DISCOVERY

A Monthly Popular Journal of Knowledge

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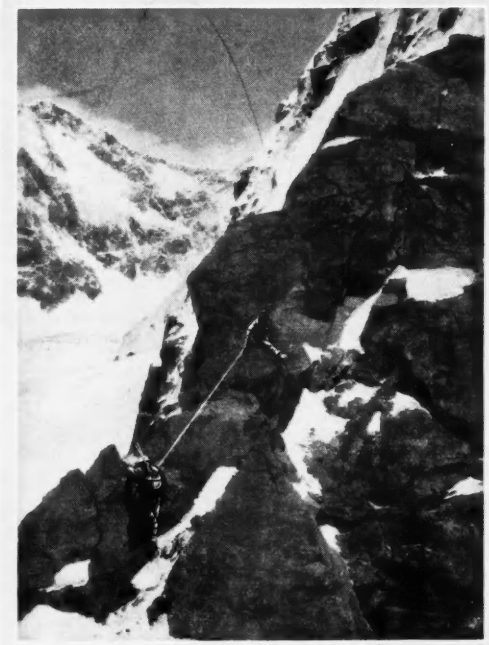

ON THE GREAT PINNACLE OF KANGCHENJUNGA.

(See page 182).

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MISCELLANEOUS ANNOUNCEMENTS

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Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

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Notes of the Month.

Some excitement has been caused in the newspapers by the announcement that scientists working in the Cavendish Laboratory at Cambridge had succeeded in "splitting the atom." Some of the reports have been rather misleading. The popular idea that the splitting of the atom will have terrifying consequences is, of course, quite mistaken. But the new experiments mark an important advance in a new subject with remarkable possibilities. The work of which this is the latest phase is briefly reviewed in this issue by Dr. A. S. Russell. Formerly an alpha particle ejected a proton; Dr. Cockcroft and Dr. Walton have shown that the reverse can occur, with "unlocking" of energy. The recent discovery of the neutron considerably widened the scope of this subject and thus paved the way to the new experiments; work on the neutron forced these workers to look out for something new instead of concentrating solely on the ejected proton. An interesting feature of the work is the fact that the results might have been obtained, with the necessary technique, at any time during the past ten years. No one thought of doing so.

* * * * *

An expedition is setting out this month for Central Brazil in search of Colonel P. H. Fawcett, the explorer, who was last heard of seven years ago. The expedition is the outcome of a new report that a white man believed to be the missing explorer was seen last October at a spot midway between the main tributaries of the River Tapajoz, where the central plateau of Brazil joins the Amazonian plain. The white man was in the keeping of an obscure Indian tribe. The problems involved are discussed on another page by Mr. W. S. Barclay, who knew Colonel Fawcett well and is familiar with the country. In view of the many difficulties of this region—and of the report of a search party sent out in 1928 that Fawcett had been clubbed to death—it is questionable whether the explorer survives. But Fawcett assured his family before he left England in 1925 that they need not be anxious if they heard no news of him for as long as five years. It is this statement which leaves hope of his survival. The new expedition is being organized in this country by Mr. P. R. Churchward who knows the country well, and will be led by Captain John Holman who is familiar with the interior of Central Brazil. The party will set out from São Paulo in the direction of the capital of Goyaz State and thence to the Upper Araguaya River. The River Mortes will be thoroughly explored, and a visit will be made to the scene of Fawcett's reported death. These plans for the expedition are provisional and may possibly be revised.

* * * * *

An aeroplane flight of nearly three thousand miles over the Antarctic is planned for next year by Mr. Lincoln Ellsworth, who has already taken part in air expeditions to the Arctic. It is proposed to fly across the unknown region between Ross Sea and Weddell Sea and to photograph the main outline with a view to a possible ground expedition which may be sent out later. The explorers are also anxious to observe the weather conditions and the nature of the ice surface. Mr. Ellsworth will be accompanied by Mr. Berut Balchen, who piloted Rear-Admiral Byrd on his South Pole flight. Meanwhile Admiral Byrd is preparing for an expedition to the Antarctic this year and will probably leave New York in September.

* * * * *

At the moment when television broadcasts are to become a regular feature of the B.B.C. programmes,

the publishers of *Discovery* have acquired the monthly journal *Television*. Television broadcasts are in future to be provided by the B.B.C. on four evenings each week. Meanwhile the successful demonstration last month of ultra-short wave television marks an important step forward. A new type of receiver was used in which the image is thrown on a screen instead of being shown in a lens. The size of the image is considerably larger so that more spectators are enabled to take part. Mr. Baird is continuing experiments both with cathode ray and mechanical methods of reproduction.

* * * * *

Palestine has been an important centre of archaeological interest during the past month. A notable discovery relating to Neanderthal Man is dealt with on another page. Meanwhile both Jericho and Tell Ajjul in Southern Palestine have provided interesting material for the student of Biblical history. Professor John Garstang's account to the Royal Asiatic Society of his excavations at Jericho dealt with the evidence from the Bronze Age tombs opened up in the past season. He has been able to determine that the fall of the city took place in the late Bronze Age, about 1400 B.C. This corroborates the narrative of the Bible as against the view that the city had already been destroyed when the Israelites entered Palestine. Sir Flinders Petrie's lectures on his work for the British School in Egypt at Tell Ajjul, the ancient frontier city near modern Gaza, once more emphasize the importance of this site as a source of information on early Palestine. It has undoubtedly done more to explain the early history of the country than any other site. Its occupation extends from the Copper Age at about 3400 B.C. to the time of Thothmes III ; and a succession of no less than five super-imposed palaces has been demonstrated.

* * * * *

In view of the forthcoming Conference at Ottawa a special number of *Discovery* is being planned for July, when "Science and the Empire" will be the theme of our editorial pages. Lord Lugard will contribute an article on the five-year research plan of the International Institute of African Languages and Cultures. Research in the Empire universities and kindred institutions will be the subject of an article by Sir Stephen Tallents, who will indicate the links between various branches of research in the Empire and similar work in this country. The past year or two have been notable for the number of aeroplane flights, and an article will be devoted to the significance of pioneer work in this respect. There will be other appropriate articles, including an account by Mr. R. E. Moreau of his latest discoveries in bird life in East Africa, and an article by Dr. Malcolm Burr on the Luano Valley, a region in Rhodesia of much scientific interest about which little is known. *Discovery* goes to many outlying parts of the Empire, and the July number will be of particular interest to our overseas subscribers no less than to those at home.

* * * * *

Since its foundation nearly twenty years ago the Norman Lockyer Observatory at Sidmouth, Devon, has been maintained entirely by private donations. An important addition to the equipment has now been made by Dr. Robert Mond, who has presented a unique instrument consisting of a battery of four cameras mounted on a pillar. By means of clockwork they follow the stellar movements automatically and register by photography whatever appearances may be made over a wide field. The new instrument was on view on May 28th, when the Astronomer Royal opened the building in which it is housed.

* * * * *

Provisional plans are now announced for the annual meeting of the British Association at York, where the Association was first established in 1831. The meeting will be held from August 31st to September 7th, and the President this year is Sir Alfred Ewens, who will deliver an inaugural address on "An Engineer's Outlook." Other arrangements include the presidential address in the Section of Mathematical and Physical Sciences, to be given by Professor O. A. Rankine on "Physics in Prospecting for Minerals." Dr. W. H. Mills will preside over the Chemistry Section and give an address on "Some Aspects of Stereo-Chemistry." In the Geology Section the presidential address by Professor P. G. H. Boswell will be on "The Contacts of Geology : The Ice Age and Man." The president of the Section of Zoology will be Lord Rothschild. Professor H. J. Fleurs will give a presidential address in the Geography Section on "The Geographical Study of Society and World Problems." There will be papers in the Section of Economic Science and Statistics on the location of industries, the effects of the world depression on the banking systems of Central Europe, and the economic position of Japan. The address of the section president, Professor R. B. Forrester, will be on "Britain's Access to Overseas Markets."

* * * * *

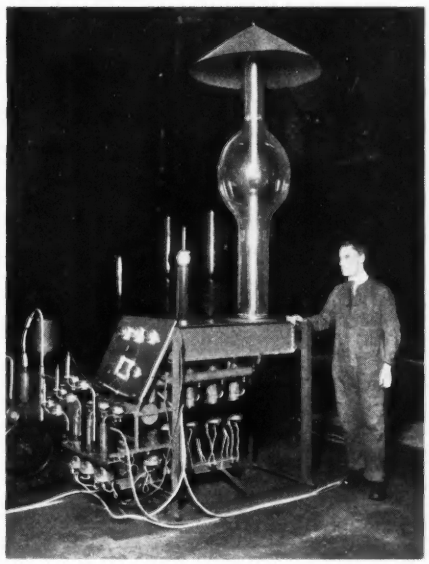
The Danish Government has granted permission to the two American air services, with which they have been negotiating, to investigate meteorological conditions in Greenland with a view to establishing an air service from America to Europe via Greenland.

The New Experiments on the Atom.

By A. S. Russell, D.Sc.

The new experiments in the Cavendish Laboratory at Cambridge have been described in the Press as "the splitting of the atom" and as something entirely novel. They are more properly the latest phase in one of the most interesting pieces of work in physics done since the War. The discovery is provisional only, and awaits verification.

DR. COCKCROFT and Dr. Walton have for some time been occupied at the Cavendish Laboratory in producing steady streams of protons (atoms of hydrogens which have lost their electrons) of high energies. They find that when a stream of considerable but not outstandingly high energy bombards the oxide of lithium a curious result occurs in about one case in a thousand millions. The projectile, evidently hitting the target fair and square, becomes fused with it and splits into two particles which appear to be charged masses of helium. They find also that these fragments move off with energies some hundreds of times greater than that of the proton projectile. Thus, in a simple experiment they have achieved two important things: they have produced helium from lithium and hydrogen, and they have tapped some of the energy of the lithium atom.



THE APPARATUS.
The tube used in the experiments at the Cavendish Laboratory made by Metropolitan-Vickers Electrical Co.

The arithmetical side of the problem appears to be simple. The proton weighs 1, the lithium atoms 7, the combination in consequence weighs 8. The two helium nuclei result weigh 4 each, and two fours are eight. Actually both the proton and the helium atom are just a little in excess of the integers named, so that when eight divides into two fours there is a little mass over. Happily Professor Einstein has shown how small losses of mass may be correlated with large increases of energy. The small loss of mass which the lithium-proton combination suffers when it divides is approximately sufficient to explain the great excess of energy of the latter over that of the proton: it explains quantitatively the energy which has been "tapped." The helium particles produced in this remarkable way have been identified by eye by their scintillations on a suitable screen. They have also been detected less subjectively by instruments.

An interesting thing about this piece of work is its simplicity. Many people who possess the technique might have done it any time within the last ten years. The wonder now is that it was not done sooner. Some years ago Professor R. D'E. Atkinson examined mathematically the stability of a particle weighing 8 and concluded it would tend to split into two particles of 4. Recently he suggested that relatively slow protons would do with lithium what now experimentally has been done. The suggestion, however, was not followed up, and the Cambridge workers did their work in ignorance of this prediction.

In earlier work on the "splitting" of the atom the helium nucleus was the projectile and the proton part of the shattered target. Since many physical processes in Nature are reversible, it might have occurred to someone to do the disruption experiment the wrong way round, using the proton as projectile and hoping that from some element the helium nucleus would be ejected. It would be interesting to know how far the widening of the horizons of this subject, occasioned by the discovery of the neutron, has helped to suggest the new experiments. It may be, however, that they were well under weigh before the neutron was found.

In this way the modern science of transmutation is progressing. It was radioactivity, discovered amid the amazing renaissance in physics which occurred at the end of last century, which begat it. It owes its greatest debt to the insight and experimental genius of one man, Lord Rutherford. In addition to his other services to science he has kept this modern form of alchemy from getting into a mess. It began rather badly. The first reported cases of transmutation put forward by the late Sir William Ramsay and his

colleagues at University College, London, from 1907 onwards, were reminiscent of the claims made in the Middle Ages. Struck by the rays from radioactive substances the common compound water was reported to produce the rare gases argon and neon, and copper lithium, and there were even more remarkable occurrences.

The first claim which has stood rigorous examination was due to Lord Rutherford in 1919; from that time he, Dr. Chadwick and others in Cambridge, and a group of workers in Vienna, have shown that protons can be produced by disruption of the nuclei of certain light elements when the latter are bombarded by the swift helium nuclei from radioactive substances. The two sets of workers have not always seen eye to eye, a not unexpected thing since the earliest experiments depended largely on eyesight. The Viennese found that disruption occurred more widely in nature than the Cambridge workers did, but in so doing they confirmed the Cambridge results.

With elements heavier than the alkali metal potassium this phenomenon of disruption or transmutation does not occur in this artificial way. Of the light elements which do not suffer the change lithium, beryllium and oxygen are chief. The others behave similarly in emitting protons, although only on the rare occasions when they suffer a head-on collision with the helium nucleus. There is, however, no remarkable "tapping" of energy on these occasions. The whole business, in fact, is very mild and not at all in accord with a popular idea that smashing the atom will have terrifying consequences.

Of the exceptional elements beryllium has recently been shown to produce the now famous neutron as was mentioned in these pages last month. Now lithium shows its originality in no less a remarkable way. Bombarded with helium nuclei nothing very much seems to happen; bombarded, however, with protons it gives birth to helium nuclei with "tapping" of energy. It is to be hoped that subsequent work will confirm this remarkably interesting result and its extension to the elements boron, beryllium, carbon, fluorine and aluminium, which in preliminary work appear also to give helium and an atom of a third element. The whole work is a quite exceptional advance in a new subject already with a magnificent history.

Neanderthal Man in Palestine

PALESTINE is likely to become increasingly important in solving the problems of early man. Several notable discoveries have been made by the British School of Archaeology in recent years. The Galilee skull was found in 1925 by Mr. Turville Petre and was the first Neanderthal man to be discovered outside the bounds of Europe. Miss Garrod later discovered a Neanderthal tooth and cranial bones in the cave of Shukbah, and a Neanderthal infantile skull was found by Mr. T. McCown last year. These have now been followed by the discovery of three complete Neanderthal skeletons in the rock shelter of Mugharet-es-Sukhul. This find was also made by Mr. McCown while working for the joint expedition of the British School of Archaeology in Jerusalem and the American School of Prehistoric Research on the western slopes of Mount Carmel.

The latest discovery is obviously of very great importance, especially if, as stated, the skeletons are complete. Beyond that, they may have a further significance in their bearing on the special character of Neanderthal man as he existed in Palestine. The skull found by Mr. Turville Petre in 1925 was fragmentary and the front part of the skull and part of the face only were preserved. But there was sufficient to indicate to Sir Arthur Keith that Galilee man presented certain peculiar features in which he differed from Neanderthal man in Europe. Yet it was definitely Neanderthal and approached most nearly to the Krapina type, which was previously the most easterly example to be known. Miss Garrod's finds were too fragmentary to do more than corroborate the existence of Neanderthal man in Palestine. But the infantile skull found by Mr. McCown, although immature—it is estimated at four years of age—in the opinion of Sir Arthur Keith confirms and supplements the evidence of the Galilee skull; for the back of the skull, absent in the earlier discovery, differs from the type. This is clearly not the effect of immaturity, for it contrasts markedly with the skull of the Gibraltar child found by Miss Garrod a few years ago. Certain of these aberrant characters in Neanderthal man in Palestine Sir Arthur Keith considers to be simian; but in others he thinks the Palestine skulls approach more nearly to modern man than does European Neanderthal.

It is noteworthy that all the discoveries of Neanderthal man in Palestine have been associated with a Mousterian industry; but it is equally remarkable that in each case the industry has certain peculiar features which mark it off from the European Mousterian.

The Mystery of Colonel Fawcett.

By W. S. Barclay, F.R.G.S.

Author of "The Basin of the River Parana," etc.

Mr. Barclay had many years personal acquaintance with Colonel Fawcett both in England and in South America before the explorer mysteriously disappeared in 1925. He therefore discusses the new expedition sent out in search of Colonel Fawcett from first-hand knowledge of the problems involved.

SELDOM have any "travellers' tales" excited more interest than those which have, from time to time, been connected with the disappearance of Lt.-Col. P. H. Fawcett, D.S.O., last heard of in May, 1925, in Central Brazil.

The Latest Clue.

The latest rumour concerning this distinguished and veteran South American explorer comes from Anton Rattin, a Swiss subject of twenty-one years residence in Brazil. In February last he reported to Mr. Abbott, British Consul at São Paulo, that in October, 1931, midway between the main tributaries of the River Tapajoz, where the central plateau of Brazil joins the Amazonian plain, he had met and talked to a white man, guarded by an obscure Indian tribe, whom he now declares to have been Fawcett. As this goes to press, Rattin has undertaken a return journey to rescue his white man from the tribe, to which he gives the name of Murcielagos (the Bats).

To get a true perspective of Colonel Fawcett's disappearance, it is necessary to consider his previous record. All his life and up to the very day of his presumed death, he had been engaged in hazardous travel and work. He was the ideal explorer, skilled in survey, rapid and accurate. Despite his age—if living he would now be sixty-five years old—he could endure hardship better than most younger men. Brave without foolhardiness, of infinite resource in emergency, he had twenty years' experience of South America.

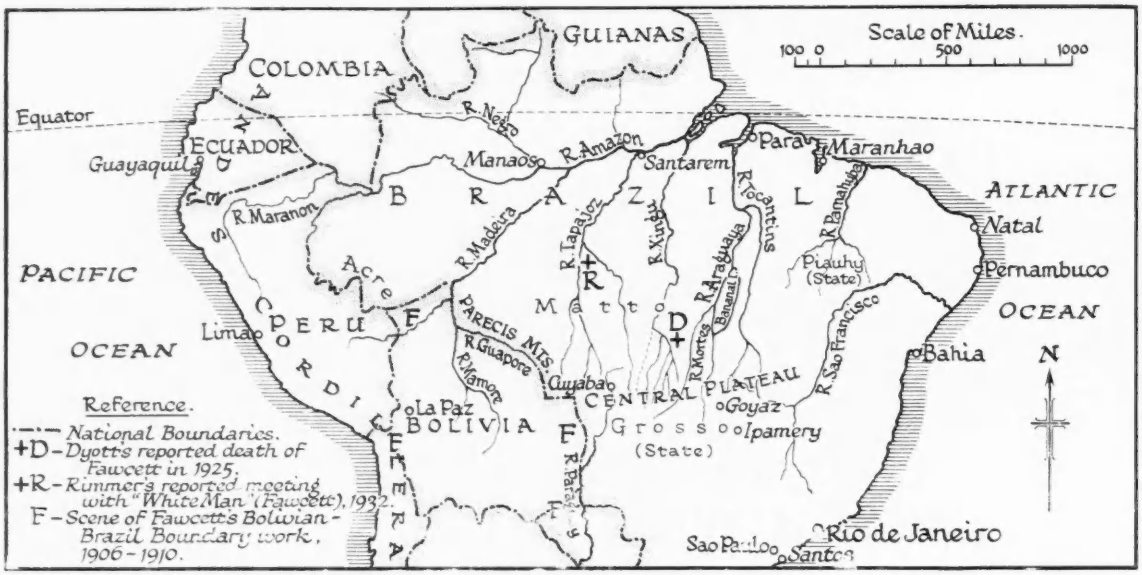
Fawcett's bent towards exploration was early apparent. In 1900 he took the survey diploma of the Royal Geographical Society, and in 1901 he accompanied a mission to the interior of Morocco. In 1906, after a distinguished career as an artillery officer, his services were loaned by the War Office to the Bolivian Government, to assist in the delimitation of the frontier with Brazil lying within the watershed of the Upper Madeira river, that is, in the region between the foothills of the Bolivian Andes and the western (Matto Grosso) escarpment of the Central Brazilian Plateau. This boundary work he brought to a successful conclusion in 1910, having during its course personally conducted three hazardous river explorations through unknown territory.

This Brazil—Bolivia hinterland—with its contours blanketed by tropic forest, its heavy rainfall and uncertain rivers, its hostile Indian tribes, its lack of reliable labour or transport, above all its fevers and illnesses due to an intolerable profusion of insect pests—is one of the most difficult in the world to penetrate or map successfully. Fawcett's work, briefly summarized in papers published in the *Geographical Journal*, gained him in 1917 the explorer's highest honour, the award of the R.G.S. Founder's Gold Medal.

Fawcett's interest in this Southern Amazon region did not terminate with his official duties. Resigning from the British Army he engaged during 1913-14 in a private expedition which he broke off to serve in the War as soon as the news reached him. The paper he contributed to the R.G.S. on this journey, published in its *Journal* in 1915, is probably unique in the annals of the Society. For while it gave many details and photographs, the actual new area explored was left undefined; and so remains to this day, except by inference. The explanation given was that, after the interruption of the war, Fawcett hoped to return and give his final results at a later date—a promise which still awaits fulfilment.

In Unknown Territory.

After serving through the War, where he gained the D.S.O. and was four times mentioned in dispatches, we find Fawcett back in South America between 1919-1921, and for the most part in the interior. The *Geographical Journal* of this date, however, states that "our Gold Medallist, Col. P. H. Fawcett, *who since his work on the Brazil-Bolivia boundary has kept his eyes fixed on the little-known regions of Western Brazil*, is now starting an expedition into a territory never penetrated even by the Bandeiristas of Portuguese days." Coming over the old trail from Cuyaba across the Central Plateau, he crossed the Plate-Amazon divide and struck in a north-east direction over the numerous headwaters of the Xingu river. The waters descend from 2,000 feet altitude on the plateau to unite some 200 miles further north in a single channel.



MAP OF THE REGION OF COLONEL FAWCETT'S EXPEDITIONS.

Still reserving to himself the results of these later journeys, Fawcett again sailed for South America in 1925, this time accompanied by his elder son, Jack, and a friend, Mr. Walter Rimmel. Once more his venture is reported in the *Geographical Journal*: "Fawcett has started on a new expedition into the remote recesses of South America in fulfilment of a project . . . which he made the first attempt to carry out in 1920. Col. Fawcett has long held that traces of lost early civilization may still be found in forests of the interior; *he cites buried cities near the borders of Piauhy*. . . . "

In 1927, when anxiety was beginning to be felt as to his fate, the President stated in his annual address to R.G.S. Fellows, that "His (Fawcett's) line was to strike north from Cuyaba (Matto Grosso) to the headwaters of the Xingu and *at lat.* 11 *south to turn across more than* 1,000 *miles of unknown country to the Atlantic.*"

Now the state of Piauhy, and the Araguaya, and Tocantins waterways which lie midway between that State's border and the Xingu river, are nowhere 800 miles at furthest from the Atlantic coast, which is, moreover, penetrated for considerable distances inland by railroads from Pernambuco, Bahia and other coast ports; while the base of the Tocantans river is Para, the *entrepot* for the whole Amazon valley. For over eighty years this region has been criss-crossed by cattlemen, traders, rubber-gatherers and railway survey outfits, to say nothing of the half-breed Bandeiristas and their descendants since the Portuguese Colonial era. Why should Fawcett announce as his objective a route leading over plateau and mountain country towards Piauhy and the Atlantic coast, instead of to those little-known and still unexplored regions farther west? However this may be, he undoubtedly in 1920 crossed the Xingu head streams in a north-east direction. But in 1925, after dismissing his last Brazilian peons, the small party of three Englishmen, shouldering all their kit, in pursuance of Fawcett's theory of "living on the country," disappeared into the bush-scrub of the central plateau. Their last letters home were dated May 29th, and the rest is conjecture.

The narrative now brings us to February, 1928, when Commander Dyott, an English ex-airman and explorer with considerable experience of the Upper Amazon, arranged with a New York newspaper to head an expedition to look for traces of Fawcett. Following his tracks, with the aid of Brazilian officials and of men employed by Fawcett in his former journeys, Dyott finally got into touch, about 400 miles from Cuyaba and near the Upper Xingu country, with the headman, or cacique, of a tribe of "tame" savages, by name Aloique. After days of mutual communications in sign language, he gathered that Fawcett and his companions had been treacherously clubbed to death after leaving his (Aloique's) camp, by a party from a hostile neighbouring tribe. The actual spot was guessed about long. 52° 30′ by

lat. 12° 20′ south. On one of Aloique's children, Dyott saw a tin label bearing the name of W. S. Silver & Co., King St., who had packed Fawcett's boxes, and in the cacique's hut a uniform case, stated to have been given him by Fawcett. He also recognized some Kahki clothing. The bodies were not located, as Dyott's party was forced to flight by the pressure of fresh Indian arrivals.

His evidence as to Fawcett's death was accepted by the R.G.S. as final. It was based on the above vestiges of equipment, which may conceivably have remained *in situ* from the expedition of 1920, and on a correct interpretation of incidents conveyed in sign language by a treacherous savage. It is, however, by no means certain that Mr. Dyott's various discoveries at Aloique's camp were not the remains of Fawcett's 1920 trip; nor has he or any other person proved beyond doubt what route Fawcett actually followed after he dismissed his peons at "Dead Horse Camp," lat. 11° 43′ S., long. 54° 35′ W., in 1925.

Now, seven years after Fawcett dated home his last mail, and four years after Dyott's report of his death with all his party, we are asked to believe that there is the probability of Fawcett's survival. Rattin's story is circumstantial. He denies any previous knowledge of Fawcett. He reports that the white man asked him to tell a planter (fazendeiro) in São Paulo, named Paget, that he (Rattin) had met an English colonel captive. Now a Major J. B. Paget was in São Paulo in 1920, and Sir Ralph Paget was later British Ambassador at Rio. Rattin identified Fawcett's photograph amongst others submitted to him and gave details of a locket and ring worn by the white man. Enquiries are now being made on these and other points in this evidence.

FAWCETT'S PARTY.
Photographed just before setting out on the expedition. (N.A.N.A. photo.)

Rattin's story is discredited by the well-known Brazilian explorer, General Candido Rondon, who was well acquainted with Fawcett. Rondon, himself of half-Indian descent, knows the Brazilian plateau lands and tribes well, having run the Brazilian telegraph line from the coast across to the Madeira river. He reasonably enquires why a man of Fawcett's intelligence could not give a clearer message, in English or Spanish, to Rattin. Moreover, he points out that the scene of the reported meeting lies 300 miles in direct line north-west of the spot where Dyott last traced him, with difficult rivers and broken country interposed.

Fawcett is rapidly becoming a legendary figure in the interior of Brazil. Neither enquiries from England, nor those of the Brazilian Government itself, have elicited other facts than those here given. But at intervals various individuals in South America have acquired brief newspaper publicity by declaring that in the interior they had seen, or heard news of, Fawcett. On the fringes of civilization where there is no definite printed news rumour takes its place. From mouth to mouth it passes, like the wind blowing; across the uplands, down the rivers, through the forest; louder here, more faintly there, but never

LIEUT.-COL. P. H. FAWCETT.
Who was last heard of in Central Brazil in May, 1925. (N.A.N.A. photo.)

dying down altogether. The tale of Fawcett's survival persists, with the tales of lost Inca tribes and cities, of buried Jesuit treasure and wonderful gold mines, throughout these unexplored regions east of the Andes to this day.

Are the stories altogether incredible? We have witnessed in our own times the re-discovery of the Maya civilization in Central America and evidence accumulates from many lands that the countless generations before our own did not pass without leaving some trace. From first-hand evidence whose value we can only conjecture, this Fawcett believed and for this he searched. Yet for the final word as to his fate, we must await facts, not theories. Even if the treacherous blows that struck them down spared Fawcett's life or that of his companions, could he, or they, in such case have survived a subsequent seven years of savage, nomad, semi-captive existence?

On June 18th next a further important expedition is preparing to start from England to join in the search for Fawcett. It is being organized here by Mr. P. R. de S. Churchward, who has already once ascended the Araguaya river to its confluence with the Mortes. In Brazil Capt. John G. Holman of São Paulo, who is familiar with the interior of East and Central Brazil, will be in charge of the party, which will consist of ten members. The route will be from São Paulo to railhead in the direction of the capital of Goyaz State, thence by motor truck to the Upper Araguaya river, where boats fitted with outboard motors and petrol supplies will await them. They will descend to the confluence of the Mortes (on the western side of Bananal Island) and will explore that river in its entirety. An excursion will be made again westward to the spot where Fawcett's death was reported, and should their investigations determine the need for so doing, the party will proceed to the further point described by Rattin, situated about long. 57°, lat. 9° 30′ S. The whole party will go well-equipped and though not proceeding under the aegis of the Royal Geographical Society, they carry its good wishes and assistance in certain practical details.

Fawcett declared to his family and intimate friends, before he left England in 1925, that they need not be surprised nor anxious if they heard no news of him over a long period, even up to five years. It is this statement which still leaves hope that some miracle may restore him from the Brazilian wilderness into which he disappeared. Yet if he never returns, both he and his companions will have added one more chapter in that great record of gallant Englishmen who throughout our history counted their lives as naught in the pursuit of new discoveries and, win or lose, are an inspiration to those who follow after.

The Significance of African Folk Music.

THE significance of native folk music, which has largely been neglected by the student of Africa until recent years, was discussed by Mr. H. T. Tracey at a recent meeting of the Royal Anthropological Institute. African folk songs, he said, compare favourably with any folk music of the world. Songs, though composed originally by one man, are so added to by the folk that they may be termed community compositions. They are sometimes traditional, sometimes mystical, but mostly commonplace little ditties. The traditional songs often reveal historical facts that are nearly forgotten, while the mystical ones throw light on another facet of native religious life.

A study of African folk music helps and is helped by a comparative study of American negro melodies. The tonal laws of the African languages would account for the foreign melodies adopted by the English-speaking negro, while his hereditary tendencies both in tone and rhythm are still similar on both sides of the Atlantic. The negro of America is to-day seeking fresh inspiration from African folk. For our part, through our present methods of education, we tend to substitute an inferior type of music that must eventually share the same fate as Western music with the negro folk of America. Through the strength of national hereditary tendencies, any music is apt to become strangely distorted in the mouth of a foreigner. This raises the question of the real function of a national art. It would appear that African native music has in embryo sufficient theory to ensure a natural growth of that branch of art, if only it were properly encouraged to take its place in modern development. The difficulty of the technique to the foreigner has made it all too easy and attractive for him to substitute Western ideas to the detriment of local practice. Native instruments should be the foundation of any musical advance.

The real significance of African folk music is bound up with a proper adjustment of black and white personalities in the colonies, and a better grasp both by the Western educator and by the native himself of the essentials of culture.

The New Survey of London Life.

By Sir H. Llewellyn Smith.

It is nearly fifty years since Charles Booth embarked on the first Survey of London Life and Labour. The changes in the social and industrial life of the city since that day have now called for a new survey, on similar lines though far wider in scope. The work is here outlined by Sir H. Llewellyn Smith, the author of the new survey.

THE new Survey of London Life and Labour has now been in progress for nearly four years and may perhaps continue for two years more. Two volumes of results have already been published, and there are likely to be four more volumes of text and two of maps, making eight volumes in all.

The main object of the Survey is to ascertain how the mass of Londoners live, what they earn and what they can buy with their earnings, how they work and under what conditions, how they are housed and how they spend their leisure, how many of them are living in poverty or in comfort, and in what degree and in what directions and from what causes they have changed in all these respects since the great pioneer Survey of Life and Labour in London was carried out by Charles Booth in the 'eighties and 'nineties of last century. The new Survey is, in fact, an effort to repeat as nearly as the changed conditions permit the inquiry which Charles Booth began in 1886 and completed in 1903.

Charles Booth was a man with a genius for investigation, and the inquiry which was carried out during those seventeen years at his initiative, under his direct and constant superintendence and entirely at his own expense, marks an epoch in social research, both as regards its objective, its scale and its methods. His prime object throughout was not to support a theory or to argue a case, but to draw a true picture, with light and shades neither suppressed nor exaggerated, of the social and economic conditions prevailing in London in his day. Only to a slight extent and incidentally did Charles Booth deal with history, causes or remedies, although in point of fact his researches formed the starting point of a number of social reforms—a conspicuous case being Old Age pensions.

Degrees of Poverty.

The seventeen volumes in which his results were embodied range over a wide field, but the central feature of the Survey which caught the public attention most was his attempt to make a numerical classification of London population in a series of ascending grades designated by letters A to H, according to their degree of poverty or welfare, and to illustrate the local distribution of these different grades by coloured street maps with a corresponding series of tints, ranging from the black of crime and the blue of poverty through purple, pink and red to the gold of wealth. Another branch of his Survey was devoted to a detailed and most valuable description of London industries, which has hardly perhaps even yet received the full attention it deserved, while a third and final series of volumes endeavoured to estimate the religious and social influences (in the widest sense of the term) by which the life of Londoners was affected.

How London Lives.

Such a picture drawn by such a master hand enables us to say with confidence how Londoners lived and worked thirty or forty years ago. But being almost wholly static it could not give an answer to the insistent question whether and how far poverty is gaining on welfare, or welfare is gaining on poverty. To throw light on this problem of tendencies it was essential that the inquiry should be repeated, keeping the standards so far as practicable on a comparable basis. This is what the New Survey aims at accomplishing. The attempt has been made possible by the initiative of the London School of Economics and Political Science, and the generosity of the Trustees of the Laura Spelman Rockefeller Foundation and of certain other Funds and Foundations, and some of the London City Companies.

Forty years is a very long gap—too long and too full of changes to be successfully bridged merely by a repetition of the original inquiry. Accordingly, our first volume was devoted entirely to a historic retrospect—an attempt to trace and measure the changes in social conditions which have taken place in London in the past forty years, so far as can be ascertained from the data and material already in being. Within these restrictive limits we tried to establish as many lines of connexion as possible between the present period and that covered by Charles Booth's inquiry, as a preliminary and starting point for the New Survey proper.

I have spoken of comparability, but over so long a period this is not to be attained merely by slavish adhesion to identical standards. For example, the centre of gravity of London working-class life has shifted so far eastward as to make it impossible to

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limit the survey area to the County of London to which Charles Booth confined his inquiries. It would be quite misleading to exclude from any picture of London poverty and economic conditions the great conglomerations of working population which have grown up in the past half century to the east of the River Lea. Thus we have been compelled to take into our Survey one-and-a-half millions of persons outside the County of London, in order to obtain a fairly comparable unit.

Then again it would be absurd not to make full use of the many sources of information which have been opened up since Charles Booth's time. Some of these (for instance, National Insurance Statistics or the Labour Statistics compiled by Government Departments) are for the most part fresh sources; others like the improved Census material are at least partly the result of Charles Booth's own work.

Many Comparisons.

It is neither necessary nor possible in a short article to enter into the many difficulties of measurement which beset the path of those who attempt to make a comparison of social conditions over a space of forty years—difficulties, for example, of establishing any definite meaning capable of measurement to such terms as "poverty," "cost of living," "necessaries" and "real income," during a period marked not only by great fluctuations in values but by equally great changes in the popular conceptions of what constitutes a "minimum" standard. For all this reference must be made to the published volumes.

There is, however, one vital matter which I think it necessary to stress, if only as a warning. Averages tell much, but they do not tell everything. If the rise of real earnings of every individual worker in London corresponded with the "average" ascertained rise for the whole body of workers we should be able to estimate the decrease in the proportion of the population who are living below Charles Booth's poverty line. But before we can say whether the actual reduction in poverty has been of the same order, or greater or less than the reduction thus calculated, we must explore the distribution of poverty and welfare within the average, and ascertain beyond doubt how far the rise has been an all-round improvement, or how far it is the resultant of two opposite movements at the two ends of the scale. For it is theoretically conceivable (though very improbable) that a rise of average earning power might be concurrent with a depression of conditions or an enlargement of numbers of those that are worst off.

I say it is very improbable, because wages movements are not independent but generally move in sympathy, and it is known that the wages of unskilled labourers have increased at a more rapid rate than those of skilled craftsmen. Still, the possibility of divergent movements cannot be excluded without further inquiry, especially as the mechanization of industry sometimes produces as a by-product a certain debris of workers whose skill is no longer in demand and who cannot be readily absorbed. Moreover, the effect of modern urban life and increased social and medical care on the generation and survival of mental and physical defectives (who make a big contribution to the economically subnormal classes) is a matter requiring the most careful exploration.

For all these reasons it is clear that the tracing of "average" tendencies needs to be supplemented by an intensive investigation of the actual distribution of the London population among different social and economic grades in order to establish what Charles Booth called "the numerical proportion which poverty, misery and depravity bear to regular earnings and comparative comfort." This investigation will be the subject of the next four volumes of the Survey.

These volumes have a fourfold purpose. The first object is to classify the population in social and economic grades corresponding roughly with Charles Booth's classes, and to determine what is the percentage of the population now living in "poverty" to be compared with the 30 per cent which resulted from his analysis. The second object is to show the local distribution of economic conditions street by street by coloured maps corresponding as nearly as may be to Charles Booth's "poverty" maps.

Recreation and Vice.

Thirdly we have to deal with a series of special subjects having a direct bearing on poverty, such as housing, unemployment, old age, mental deficiency, vagrancy, crime, and the like. Lastly we hope, if time and space and funds permit, to explore a number of topics bearing on London Life and Labour which may be broadly described as the use of leisure, including all forms of activity and recreation not connected directly with the earning of a livelihood, such, for example, as household economy, sports, hobbies, holidays and amusements, clubs, societies and means of cultural improvement, but also including such anti-social habits as drink, gambling and vice.

In the social and poverty survey we are following concurrently two main methods:

(1) The extensive method, chiefly employed by Charles Booth, of collating and analysing all the information procurable by indirect means as to the

social and economic conditions prevailing in every street, or section of a street, from persons and bodies who acquire such information in the ordinary course of their duties. The principal sources we are tapping for this purpose include school attendance officers, employment exchanges, poor law relieving officers, police, and others, and in certain areas house agents, in addition to which many of the streets have been personally visited by members of the staff. The number of streets or street sections in the Survey Area separately investigated is nearly 30,000.

Classifying Each Street.

On the basis of all the information obtained we classify the population of each street under letters corresponding as nearly as we can make them to Charles Booth's classes, except that we are massing together some of these classes which have dwindled in magnitude and sub-dividing others which have expanded, and we are making a number of detailed modifications in the colour scheme of the poverty maps to suit the new conditions. None of these changes affects the position of the poverty line.

(2) Concurrently with this extensive survey which covers the whole area, we have been conducting a more intensive sample inquiry under the direct supervision of Professor Bowley, on the principle of "random sampling" which had already been applied by Professor Bowley and his colleagues to ascertain the measure and trend of poverty in a group of provincial towns. The number of working-class households included in the sample for which particulars have been obtained is nearly 30,000, and we are satisfied both from the methods of sampling employed, and from various tests applied to the data, that these households are a fair and adequate sample of the working-class population of London. The results of the sample inquiry promise to be of extreme interest.

We have been at the utmost pains to ensure that the standard of poverty adopted both in the street survey and the house sample inquiry shall be as nearly as possible comparable as between themselves and also with Charles Booth's standard. Obviously the value of the comparison depends on substantial identity of standard. This subject was discussed by me at length in a paper read before the Royal Statistical Society in June, 1929, and was further considered in the first volume of the Survey. The result was to show that the standard of income employed by Charles Booth corresponded fairly closely with the objective standard based on minimum consumption adopted for the house sample, and that an income of 40 shillings in 1929 (the date to which the main Survey relates) was roughly equivalent to one of 21 shillings in Charles Booth's time as the income for an "ordinary family" at or about the poverty line.

There is one point, however, of great importance which I should like to stress. There is not the least doubt that the great development of the public provision for such emergencies of life as sickness, old age and unemployment, combined with the extension of public assistance, has greatly altered the real significance and character of poverty itself, by mitigating its most terrible feature—the constant hazard and fear of destitution. That is a vast gain; but for the comparative statistician it introduces a new element of complexity. Moreover, while the actual physical hardships caused by poverty have diminished, there has been a concurrent change in the ideas generally held of the minimum necessary for a civilized existence. In order to preserve comparisons it has been essential to base the New Survey on the old standards. But these standards no longer represent the current view of what constitutes "poverty."

I have left myself no space to describe the Industrial Survey, of which the first part is contained in the second volume published in the autumn of 1931. This consisted of a series of detailed studies of conditions and tendencies in a number of the most important and characteristic London industries—building, engineering, furnishing, clothing, boot and shoe making, dock labour and domestic service. It will eventually be followed by another volume dealing with the principal remaining industries and also with the great groups of distributive, transport and commercial occupations. This industrial inquiry is the complement of the social survey, and throws much new light on the factors which contribute to poverty or wellbeing—*e.g.*, low or high earnings, unemployment, and the mechanization of industry.

The Future.

I only wish in conclusion to emphasize that the purpose of the New Survey is to lay a firm foundation for future comparisons quite as much as to make a comparison with a past period. It is in relation to future comparisons that the double method of investigation employed assumes its greatest importance. This should make it possible to adapt the poverty line to changing conditions and conceptions, while still maintaining an unbroken thread of continuity between past, present and future.

Recent Conquests in the Himalaya.

By N. E. Odell.

In contrast with the general exploration of the greater ranges in pre-war years, recent mountaineering has been marked by the number of attacks on high peaks. The author outlines the more important achievements in the Himalaya during the past two years, of which the Kamet and Kangchenjunga expeditions are outstanding.

IN *Discovery* for February, 1931, that world-famous mountaineer and traveller, Lord Conway, gave a most excellent account of the inherent nature of, and the intrinsic difficulties attendant upon, mountaineering in the Himalaya. He sketched the contrasts displayed by the Great Himalaya with other mountains and in particular with the Alps. He showed how the climber trained only in the Alps is at first invariably deceived, not only by the colossal scale of the Himalaya, but by what may be called its dangerous "youthful" activities.

For, geologically speaking, the Himalaya are in part a younger mountain system than the Alps, and indeed may be still growing. This condition results in an instability of structure that spells danger to the unwary. The final tragic experiences of the second Mount Everest expedition of 1922—though of a rather different and perhaps more normal Alpine nature but involving the deaths of seven porters—brought home again the risk of avalanche in the Himalaya to those who do not exercise an inordinate amount of care, and who cannot speedily readjust their sense of values in the entirely different environment in which they find themselves.

The pre-war period was especially preoccupied with exploration of the greater ranges and glacier systems of the Himalaya, and in proportion to the number of expeditions accomplished, there were relatively few attempts on the greater peaks. It can probably be correctly said that the three post-war expeditions to Mount Everest inaugurated an era of actual assault on the high peaks themselves, particularly in regard to the eastern end of the Himalaya. On Mount Everest it was shown that by methods of team-work and deliberate rather than precipitate action, with consolidation of each higher position gained, it was possible to reach altitudes that many had considered would be impossible of achievement without such aids as an artificial supply of oxygen gas. For it must not be forgotten that at the altitude of the upper parts of Everest the oxygen-content of the air is only about one-third that at sea level. On Kangchenjunga, with its altitude of about 28,200 feet, similar altitude difficulties were to be expected, and in addition mountaineering difficulties of a higher calibre than on Everest, owing to the steeper cliffs of its upper portions.

Kangchenjunga first became well known to geographical science from the classical journey accomplished round it in 1899 by Dr. Douglas Freshfield's party. Apart from a number of smaller enterprises to tackle the mountain, mostly before the war, the so-called International Himalayan Expedition of 1930 was the first grand assault. It was composed of five Germans, three Englishmen, two Swiss and an Austrian, and was led by Professor G. O. Dyhrenfurth of Zürich, who was accompanied by his wife as secretary and quartermaster. The original plan was to travel from Darjeeling through Sikkim by the eastern side of the mountain and thus attain the northern face. But unexpected permission was obtained from the Maharaja of Nepal to enter that closed territory, and this was effective in diverting the expedition to make the journey via the western side.

THE SUMMIT OF KANGCHENJUNGA.

A view by Mr. E. S. Smythe of the summit of the famous peak seen from a camp below. The International Himalayan Expedition of 1930 was the first important assault on the mountain.

Two high passes, the Kang La, 16,373 feet, and the Mirgin La, 14,853 feet, had to be crossed from Sikkim into Nepal, and on account of the lateness of the winter and the lowness of the snowline, the position at one time was sufficiently serious to threaten the further advance of the expedition. Many of the porters were insufficiently equipped for such high passes and there was much suffering. But by dint of the most self-sacrificing efforts on the part of Colonel H. W. Tobin and two British transport officers, as well as the timely arrival of supplies from the Maharaja of Nepal at Khunza, the expedition was eventually enabled on April 26th to pitch its base camp at a height of 16,569 feet opposite the tremendous north-west face of Kangchenjunga. The scene here must be a truly impressive one. Freshfield in his classic book "Round Kangchenjunga," and F. S. Smythe, who accompanied the present expedition, in "The Kangchenjunga Adventure," have vividly described the appalling grandeur of this profound glacier valley, leading to the vast northern wall of Kangchenjunga itself, with its tiers of icy precipices rising to the final receding summit, 10,000 feet above its base, and 28,200 feet above sea level. Looking at this face in 1899 Freshfield had said, "I failed to trace any route on which skill could avert the danger of avalanches, and with Mummery's fate (on Nanga Parbat) before our eyes, this approach to Kangchenjunga cannot be recommended even to the boldest climber until such a route has been discovered."

KAMET FROM CAMP 4.

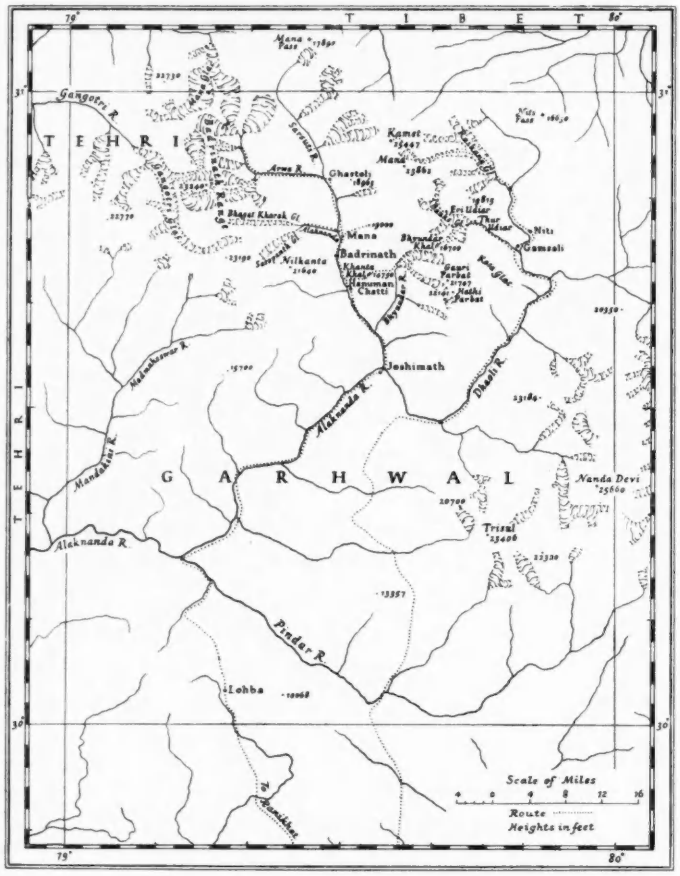
The outstanding expedition to the Central Himalaya last year was the ascent of Kamet, the second highest peak in British territory.

Yet with no alternative, and in the light of Alpine experience alone, admittedly deceived as to its real scale and proportions, the party unanimously set forth for the great wall with a feeling of confidence as to its accessibility. But, as Dyhrenfurth has written, they had all grossly under-estimated the general steepness of the face and the great danger from ice avalanches. From a second camp above the base camp, pitched at the head of the basin of the great Kangchenjunga Glacier, a concentrated attack was made on the ice cliffs supporting this northern face. Six of the climbing-party, under Smythe and Schneider in turn, devoted themselves for a week to the task of hacking a staircase up well-nigh vertical walls of ice. The work to the first terrace was all but completed when a portion of these very walls, beneath which one morning the party were already moving to the assault, collapsed with a thunderous roar that only those can appreciate who have heard the intensity of a large ice-avalanche.

Miraculously they had happened to be at the extreme flank of the avalanche's path, and only the merest fringe of the falling mass had touched the main party. The patent deadly danger of the northern route forbade consideration of a further attempt, and the party turned to the North-west Ridge of the mountain. Led by the indomitable Schneider "of boundless energy," the party attained an altitude of more than 21,000 feet before it was adjudged that the extraordinary obstacles ahead would entirely prevent the getting up of porters and supplies, even if the difficulties moderated, which seemed doubtful. Not only would it have been impossible to pitch a camp on the sharp and exposed ridge, but the length of the route, over several subsidiary summits, seriously militated against success. In consequence the assault on Kangchenjunga had to be given up altogether; the mountain had proved to have even greater defences than had been suspected, and its dangers were of an order unknown in the Alps.

But if Kangchenjunga were unassailable, there were other lower peaks in the vicinity, of magnificent aspect and great eminence, and to them the party now turned their attention. Close at hand was Ramthang Peak, 23,311 feet, which on foot and on ski was speedily climbed by Schneider and Smythe. Others in the neighbourhood which were ascended were

Nepal Peak 23,470 feet, Dodang Nyima 23,623 feet, and others unnamed of rather less altitude. But on Jonsong Peak, 24,473 feet, on the Tibetan frontier a record for this and any previous expedition was established, since it was the highest actual summit to be definitely attained thus far. On Everest higher altitudes were reached by several parties on two of the expeditions, and although Mallory and Irvine were seen within about 800 feet of the top, it remains an open question as to whether they actually got there. But the record of Jonsong Peak was not long to remain. The International Himalayan Expedition of 1930, however, in spite of failure on Kangchenjunga, can claim to have been successful in ascending four peaks of over 23,000 feet and four or five others of over 20,000 feet.



MAP OF THE APPROACHES TO KAMET.

In 1929 the eastern side of Kangchenjunga had been the scene of a dogged attack by a party of Bavarian mountaineers, led by Dr. Paul Bauer. From its great north ridge Kangchenjunga throws out an immense easterly spur which for 8,000 feet drops abruptly to the Zemu Glacier. Surmounting difficulties of peculiarly steep and fantastic ice formation, and cutting caves for camping sites in the solid ice walls and ridges, this dauntless party struggled on to a height of 24,272 feet, before bad weather necessitated retreat. And retreat under the appalling snow conditions which followed, carried out successfully and safely, constituted, as was said in the *Alpine Journal*, a feat without parallel, perhaps, in the annals of mountaineering.

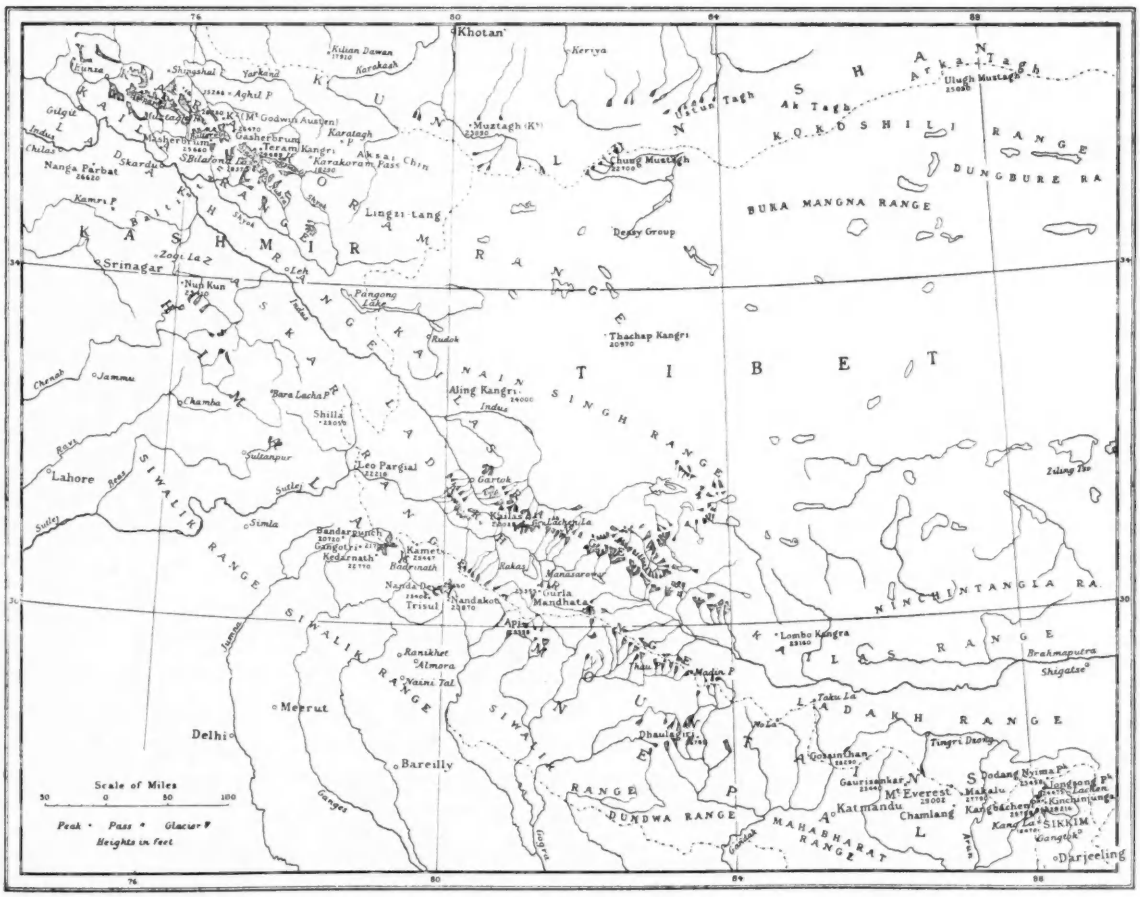
But such was the grim determination of this Bavarian party that they actually returned to the attack on the same formidable north-east spur of the mountain last summer (1931), since all other ridges seemed to offer even greater difficulties and dangers. The severe happenings of 1929 were eclipsed in the terrible tragedy that befell them, when at 20,000 feet Schaller and one of the porters slipped in a steep ice gully and fell over a thousand feet to their doom on the glacier below.

Undeterred by this disaster and with characteristic doggedness, the party attacked the terrific ridge again. At 23,600 feet they seemed to have surmounted the worst difficulties, and from their high position the mountain scenery was so overwhelming that each day they were inspired with new enthusiasm for the task. Beyond Camp 10 ice-axes were rarely used, and the fight was now against deep snow. In spite of it and carrying heavy loads they toiled on and established Camp 11 at about 25,256 feet. On September 17th Hartmann and Wien, and later Allwein and Pircher, stood on the highest point of the north-east spur at just over 26,000 feet. There they had a most disagreeable surprise, for the spur was found to be separated from the main north ridge of the mountain by a steep and treacherous snowy wall, perhaps 600 feet high. This was carefully examined and found to be in such an avalanchey condition that to have essayed its ascent would have been courting disaster for the climbers.

With the peak of Kangchenjunga shining above them, not more than 3,250 feet away, with all the many months of arduous labour devoted to the task, and the weather fine and calm, it was indeed the bitterest disappointment to have to retreat. But there was no choice. They had accomplished amazing things on such a mountain, and at such a height, and they had demonstrated once again, as had been done on Everest in 1924, the truth of high altitude acclimatization; for between 25,000 and 26,000 feet they had been able to ascend at the astounding rate of as much as 650 feet an hour, and this in deep snow and with heavy loads. It was considered that with one more camp (12) on the main north ridge, the summit would have been attained and no difficulties encountered greater than, or indeed as great as, those overcome below. But it was not to be, and with heavy hearts they reluctantly made their long descent to the Zemu Glacier, and so through Sikkim, by devious exploratory routes, homewards.

Turning to the Central Himalaya, the outstanding expedition in 1931 was the ascent of Kamet, 25,447 feet, the second highest peak on British territory proper, situated on the frontier of Garhwal and Tibet. One of the principal objects of the Kamet Expedition was mobility, so that not only could the chief mountain in the programme be easily and quickly reached, but also the party be the better able to explore the magnificent and only partially known Badrinath Range to the westward.

By efficient management, excellent organization and rigorous differentiation between the essential and unessential a total of 70 porters only, including ten of the Everest and Kangchenjunga die-hards, were required, compared with 350 of the Kangchenjunga expedition, and the equivalent of 770 porter-loads of the third Everest expedition. A start was made



MAP OF THE HIMALAYA, SHOWING KANGCHENJUNGA, KAMET AND OTHER IMPORTANT PEAKS.

from Ranikhet in Almora on May 13th, and the route up and down over the foothills eventually led on June 7th to Niti, a little village deeply set in the mountains of northern Garhwal. Within ten miles of Niti the base camp was pitched at 15,700 feet at the terminal front of the Raikana Glacier. A series of ascending camps led up the East Kamet Glacier to Camp 3, at 20,600 feet, under the eastern wall of the objective peak. Above this the climbing became more difficult, and when a route had been prospected, 600 feet of rope, fastened to pitons, had to be fixed before it was safe for porters unaccompanied by Europeans.

Camp 5 was pitched at about 23,300 feet just below Meade's Col, the notable saddle on Kamet's shoulder reached in 1912 by that Himalayan veteran C. F. Meade. From this camp Smythe describes the outlook as magnificent. Above them rose the last 2,000 feet of snow and ice slope, and their hearts sank as they gazed up at the final 400 feet set at a high angle. The snow became soft and execrable and rhythm of movement so important at high altitudes could not be maintained. Taking it in turns to lead they toiled upwards, here and there having to cut steps, or flounder across snow-choked crevasses. The pace was not more than 200 feet an hour, and on the final slope 100 feet of hard icy snow involved an hour's exceedingly laborious step-cutting. One of the porters, Nima Dorje, collapsed, but the great-hearted Lewa insisted on carrying his 20 lbs. of photographic and cinematographic apparatus as well as his own. The ultimate steep stretch cost the greatest effort of all, but at 4.30 p.m. they stood on the summit.

"Peaks of Glaring Ice."

Smythe has described the overpowering scene thence as follows: "It is difficult to render any account of the view. We were far above the world. One's eye passed almost contemptuously over mighty range upon mighty range to seek repose in the violet shades of illimitable horizons. Even the turreted thunder clouds, sun crested above, purple below, could not attain our level. The breeze fanning us was deathly cold; the silence and sense of isolation almost terrible. There were no green valleys. All about us were peaks of black rock and glaring ice or snow. Only in the north was relief to be found from this savage mountain world. There, hills streaked untidily with snow fell away into the golden plains of Tibet, tessellated with blue cloud shadows." But it was late and time vital. The summit of the mountain had only been won at great loss in physical reserve, and during the descent the party found themselves extremely exhausted.

Following the conquest of Kamet, the highest summit so far reached by man, the party crossed a high pass into the Badrinath district. Here were found fine peaks of moderate height and numerous glaciers to explore. Several summits of about 20,000 feet were ascended and a sketch map constructed of this little known region. The impression left upon the party was that in this unfrequented section of the Himalaya was an ideal district for further exploration by Alpine-trained mountaineers with moderate ambitions.

Siege Methods.

Finally it should be emphasized that the Kamet Expedition was a clear demonstration of the merits of slow deliberate progression and consequent acclimatization to the critical altitudes of the 20,000's, as opposed to the rush tactics which have been the undoing of so many previous parties on Kamet as well as other Himalayan peaks. It has at last come to be realized that the only chance of success upon the giants of the range lies in "siege" methods for the purposes of acclimatization to the low atmospheric and oxygen pressures obtaining at these altitudes. Here, as on Everest and Kangchenjunga, it has been shown that if such practice is adopted it is unnecessary for an expedition to increase its trouble and expense by oxygen-breathing equipment, and such seems only advisable as an emergency measure for the unacclimatized, or the unacclimatizable, on the supreme summits of more than 27,000 feet.

Space will not permit for more than passing reference to the several other important expeditions in recent years, to the great Karakorum Range at the north-west end of the Himalaya. Notable amongst these were the Italian expeditions in 1929 and 1930, under the Duke of Spoleto and Professor Dainelli respectively; also that under the indefatigable Dutch mountaineers, Mr. and Mrs. Visser in 1930. These were mostly explorations in but partially known regions, and few peaks were ascended. The culminating point of the range, Mount Godwin Austin, or K2, the second or third highest known summit and an unyielding objective of several earlier expeditions, notably that of Lord Conway in 1892, was more closely reconnoitred by the Duke of Spoleto's party; but nearer acquaintance seems only the more thoroughly to confirm the earlier impression that here is a giant that may only yield his secret in distant years to come when mountaineering and its methods have evolved, or perhaps deteriorated, to practices now considered outside the pale.

Mapping the Paths of Meteors.

By Harlow Shapley.

Director of Harvard College Observatory.

A party of astronomers from Harvard University is engaged in an interesting new study of meteors which is expected to throw new light on their cosmic origin. The paths of the meteors are observed with the aid of reticules and are then plotted on a map. The work is described in Dr. Shapley's report just received from Harvard.

THE nature of the interstellar and intergalactic media through which radiation, stars, clusters, and galaxies move is found to be of such significance in our understanding of galactic distances and structure that new research on the contents of space has become necessary. For several years at the Harvard Observatory we have studied one aspect of the problem —the meteors. The investigation of these small bodies bears directly not only on knowledge of their own physical nature and their place in the cosmic structure, but also on the question of the content of interstellar space. Indirectly such investigations may contribute to the solution of the general problem of " planetesimals " in the origin of the solar system, and of the structure of the upper terrestrial atmosphere.

In spite of the superiority of the photographic plate over the human eye in most astronomical studies, in the field of meteoric astronomy photography still plays a minor role. Several hundred meteors are visible to the unaided eye to one that can be photographed. The Harvard collection of plates is, however, systematically searched for photographed meteor trails. The plates have occasionally yielded results unobtainable by ordinary visual methods, though they have contributed little towards the solution of the more important meteor problems.

New Research.

During the past year the problem of the visual observation of meteors has been taken up in a systematic way, and a special expedition was organized for the study of meteors. The writer visited sites in Arizona, and chose Flagstaff as headquarters. Various types of experimental equipment were then built and tested at the Harvard Observatory. A reticule house, used for visual observation, was shipped to Flagstaff, where a duplicate house was made. The results of the work promise to be even better than we had optimistically hoped. The observing conditions in the vicinity of Flagstaff appear to be excellent for researches on meteors and the number of meteors recorded is large.

The problems to be attacked by the expedition may be briefly summarized as the study of the cosmical origin of meteors. What is the distribution of their velocities, both with regard to size and direction; what is the relative proportion of solar and hyperbolic meteors; the distribution of velocities of the hyper bolic meteors outside the solar system; the absolute density of meteoric matter in space, in and outside the solar system? These are the questions to which answers in general outline may be expected from one year's observations by six observers under the favourable sky of the Arizona plateau.

The " Reticules."

At present the plan of observation is as follows: Several observers, working at two stations placed at a suitable distance from each other, register meteors in two areas of about sixty degrees diameter. Iron reticules projected on the sky are used in tracing the meteor trails. The reticules are at ten degree intervals, and are mounted on two opposite slopes of a roof of a wooden shelter, which provides protection from wind and cold for the observers. The observer looks through one eye-hole of 32 mm. diameter placed at a distance of 50 cm. from the centre of the reticule. In surveying the area, the observer has to move only his eye. Without any correction the reticules permit direct readings with an error not exceeding half a degree; with systematic corrections, the method is accurate to within one tenth of a degree, and is thus much more exact than individual meteor observations. The records consist in tracing the trails of the meteors on maps giving exact reproductions of the reticules. The time of appearance, to the nearest second (ascertained with the aid of a stop-watch), the magnitude, and the duration are also recorded.

The observations are expected to give the relative meteor frequency for different hours of the night and different seasons of the year. With the aid of methods similar to those used in the analysis of stellar motions, though more complicated, the frequency of directions will give the distribution of the directions of meteors, or the density of radiant points on the celestial sphere, the result being free of any hypothetical assumptions. Data on a great number of individual heights and real paths will be obtained.

Simultaneous and independent observations furnish a good means for studying selection depending upon

brightness, duration, direction of motion and position in the area. The final data must be corrected for the effect of selection. The reticule observations are supplemented by visual observations of meteor velocities, and by telescopic observations. For the observation of angular velocities a device is used which may be called the "double-pendulum apparatus." It consists of a six-inch square plate-glass mirror, resting on three supports forming an isosceles triangle; the support at the right angle is stationary, while the two other supports are tilted in a vertical direction, making oscillations through ninety degrees. By the use of this device the speed of the meteors may be derived from the tracing of the trajectories on a map in two ways: from the shape of the trajectory, and from the length of one complete oscillation, which, divided by the period which the oscillation takes, gives the speed.

In studying meteors the circumstances are very favourable, because the linear dimensions of the oscillation are increased along the trail and the resolving power of the eye is thus greater; also, objects of perceptible duration allow the observer to turn his eye upon them before the phenomenon ends, a condition favouring the selection of slow objects in velocity observations.

From the experience of the first month of work with this apparatus, it appears that about eighty per cent of the number of meteors seen by a reticule observer may be observed and traced on a map. For about half of these, more or less complete information concerning the velocity can be obtained. The systematic errors of observation may be checked in two different ways, namely, by meteors belonging to certain well-studied showers (in which case the effect of resistance of the air is a hypothetical factor, though not of great importance), and by laboratory experiments. Generally, the observations are not so difficult as they might seem at first, and with some experience the observer can record, in addition to the velocity, the position of the meteor with the same accuracy as in direct observations. The tracings are made on mirror image maps and stars are used for reference.

Origin of Meteors.

In combination with the results of the reticule observations, the velocity data will aid in settling the fundamental problem of the cosmic origin of meteors. Telescopic observations not only form a necessary supplement to the visual ones, but are of independent value. There are indications that the statistical constitution may be different for meteors of different luminosity, and it becomes highly important to study a group that differs widely in luminosity from the visual meteors. Simultaneous observations made by two 4-inch telescopes at two stations separated by about three kilometers distance form a substantial part of the programme. The telescopes have a field of slightly less than four degrees, with eye-pieces of magnification seventeen times. Rectangular reticules in the focal planes are used, their exact positions being checked every night by transit observations of certain stars.

Telescopic Observations.

After the first experiments with the visual velocity apparatus were made, it was decided to arrange velocity observations also with one of the two telescopes. The advantage, when compared with the visual apparatus, is that a greater number (practically all meteors seen) can be observed for velocity, and the accuracy must be much higher. An apparatus was devised which gives the same effect, on a different technical principle, as the double-pendulum apparatus. It involves an oscillation of the image without rotation of the mirror itself. A plate-glass mirror gave surprisingly good images with, of course, low magnifying power. The observations consist in tracing the apparent trajectory on a map which is a copy of the focal reticule. The results of these telescopic observations will be similar to the combined visual results, but will yield a smaller amount of material; heights also will be available. The real paths determined from visual observations will be of statistical rather than of individual value, because for the predominantly short meteors the observational errors in direction are still considerable.

Nights with bright moonlight are omitted from the programme. During one lunation, observations are carried on for twenty-three days, with from four to eight hours of observation on one night. Of the 150 hours of possible observation per lunation, about eighty-three per cent are utilizable. When the hours of darkness exceed eight per night, observations are divided into two equal sessions, with an interval of one and a half to two and a half hours for sleep at midnight; such a programme is easier to bear than six uninterrupted hours. The results of the first month of the programme are as follows: The total number of records amounts to 2,755, covering about 2,300 individual meteors; 234 velocity records with the double-pendulum apparatus were registered, of which about seventy indicate real paths. From these data one may estimate what the total number of records will be after the programme of one year is completed.

Science and Industry—IV

X-rays and New Methods.

By G. Shearer, D.Sc.

Physics Department, National Physical Laboratory.

The use of X-rays in industrial research has revealed important new facts about many materials in common use and has thus opened the way for new methods of manufacture. Some recent applications are described by Dr. Shearer, who shows how X-rays reveal the fine structure of substances not disclosed by the most powerful microscope.

THERE is a definite physical limit to the use of the ordinary microscope. By its very nature, it can never enable us to see details which are small compared with the wave-length of the light we use. This implies that never, by its use, can we obtain information as to how atoms combine to form molecules and molecules link up to form a solid. But this information is essential to a proper understanding of industrial materials. Even ultra-violet rays are far too coarse to reveal the details of atomic or molecular structures. If we are ever to obtain a picture of these we must use a light whose wave-length is thousands of times shorter than that of ordinary light. We are fortunate in having such light available. X-rays, as commonly produced, have a wave-length some five or ten thousand times shorter than the waves which give rise to the ordinary light-spectrum. They are sufficiently fine for our purpose, and if we can find a way to use them they should give us the detailed information we require.

Atomic Patterns.

The method in which they are used depends upon a very important natural property. When nature forms a solid, she does not do so by throwing the atoms together in a random and haphazard way. She always builds to a pattern. Thus, when iron solidifies out of a melt, the iron atoms arrange themselves in a cubic pattern with an atom at each corner of the cube and one in the centre of the cube. These cubes are packed side by side, row on row, layer on layer, each cube being identical in size and contents with every other cube. It is this regularity of arrangement which we recognize when we speak of a substance as crystalline. If the pattern runs throughout the whole of the material without a break, we get the large single crystal. If, as happens much more frequently, there occur from time to time breaks in the pattern we get the crystal aggregate. In each member of such an aggregate the pattern is the same, but the various members do not dovetail into one another. In such a material the individual crystals may be large enough to be seen by the eye, or they may be so small as to be entirely beyond the range of the microscope. As a result of X-ray investigations we now know that this regular or crystalline structure is not the exception ; it is characteristic of practically all solid substances.

It is this regularity of arrangement in the solid and the short waves which characterize the X-rays, which make possible the method of X-ray analysis. Whenever we have light waves falling on an ordered arrangement of matter, we expect to observe diffraction effects if the distances which characterize the regular arrangement are comparable with the wave-length of the light. Thus, the colours of a piece of mother-of-pearl are due to the interaction of the light waves with the regular striations on the pearl. The distance apart of these striations is comparable with the wave-length of light. The spectrum produced by passing light through a diffraction grating is a diffraction pattern which enables us to calculate the wave-length of the light if we know the distance separating the lines on the grating, or, conversely, to calculate the distance apart of the lines if we know the wave-length of the light. So, too, if the distances separating the atoms in the regular arrangement which characterizes the crystal are comparable with the wave-length of X-rays, then, if we allow a beam of X-rays to fall on the crystalline material, we shall obtain a diffraction pattern which in its regularity will reflect the regularity of the atomic arrangement. Just as we could calculate the distance apart of the lines on the diffraction grating by observing the angle through which a known wave-length was diffracted, so from the X-ray diffraction pattern we can re-construct and measure the pattern on which the atoms or molecules are arranged.

Exact Information.

By combining X-rays with the regular arrangement of atoms or molecules which characterize the solid, we have at our disposal a method which enables us to obtain exact information as to the nature of the arrangement. The diffraction picture is, of course, not a direct picture of the atomic arrangement, but it enables us to reconstruct that atomic arrangement. Thus, if we interpose a piece of iron in a fine pencil

of X-rays of known wave-length, we shall obtain on a photographic plate suitably disposed a series of lines which enable us to deduce that the atoms must be arranged on a cubic pattern with atoms at the corners and at the centres of the cubes. Further, we can measure the size of this cube very accurately, although its dimensions are just greater than one hundred millionth of an inch. If we heat the iron to a temperature of about 900° C. we find that the pattern is now quite different. Clearly the atoms have rearranged themselves. In fact, the pattern is still a cubic one but the cube has now an atom at each corner and one in the centre of each face. Its size has grown from 2.86 to 3.61 ÅU. (1 ÅU. = one hundred millionth of a centimetre.) The X-rays thus show us exactly what happens to the iron atoms as iron changes from what the metallurgist calls the "alpha" state to the "gamma" state.

This method has been applied to the study of a very large number of substances both in the inorganic and the organic field, so that we now have a very accurate and detailed knowledge of the atomic patterns of many of the more common substances. The method is also being extensively used to obtain a better understanding of industrial materials and methods of manufacture. Perhaps a few examples of how it is being employed and the nature of the results which are being obtained will serve to show how powerful a weapon this new method has put at our disposal.

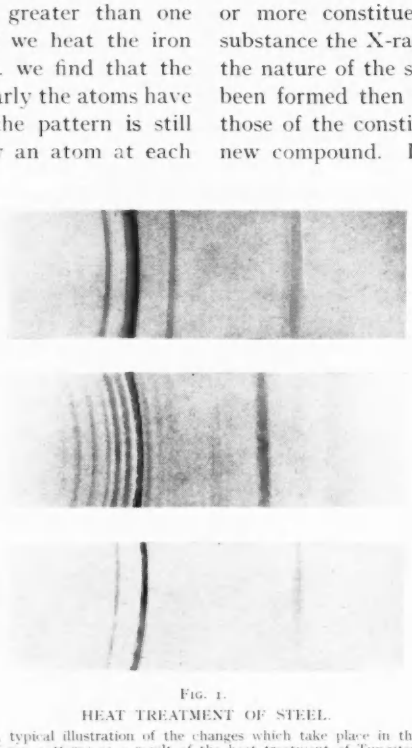


FIG. 1.
HEAT TREATMENT OF STEEL.
A typical illustration of the changes which take place in the X-ray patterns as a result of the heat treatment of Tungston magnet steel. The process is described in the text.

It has already been pointed out that practically all solids are built up in a regular fashion if only we can examine them in sufficient detail. A most important fact is that each particular substance has its own characteristic X-ray diffraction pattern and the occurrence of this pattern serves as a definite and conclusive means of identification. Thus copper, silver and gold all have patterns similar in nature to that of "gamma" iron, but the cubes are all of different sizes. Zinc crystallizes in a hexagonal pattern as does water when it solidifies into ice. The pattern of a chemical compound is characteristic of the compound and not of the elements of which it is composed, so that while iron has one pattern, carbon another, the pattern of iron carbide is quite different from those of iron and carbon and is definitely characteristic of the carbide.

The method can therefore be used immediately as an aid to chemical analysis. If, for example, two or more constituents combine to form a complex substance the X-ray method will immediately indicate the nature of the substance. If a new compound has been formed then the X-ray pattern will differ from those of the constituents and be characteristic of the new compound. If the result is merely a mixture, the pattern will consist of the patterns of the constituents super-imposed on one another. If a solid solution has resulted, the X-ray pattern will in general bear a close resemblance to that of one or other of the constituents, but will differ from it in certain small but definite ways, usually by a small change in the size of the unit cell of the pattern.

An effect of this kind is often found, for example, when two metals are alloyed. Thus, if gold is added to silver there is a gradual change in the size of the cube from the silver cube to the gold cube as the silver atoms are replaced in the cubic structure by gold atoms. In other alloy systems this replacement only occurs over a limited range. Thus if aluminium is added to copper, the copper cubes increase in size as aluminium is added until the aluminium percentage is about 12 per cent. If more aluminium is added, an entirely new X-ray pattern appears showing that the structure is no longer a cubic one. A change of phase has occurred and the new phase is characterized by a different atomic arrangement. Each phase is characterized by its own physical properties, and it is of the greatest importance that we should know how the atoms are arranged in the different phases of an alloy system.

It is well known that the physical and mechanical properties of steel can be varied within very wide limits by heat treatment. Fig. 1 is typical of the changes which occur in the X-ray patterns as a result of heat treatment. These three photographs are all characteristic of a tungsten magnet steel. The first

is the steel in the " as-rolled " condition. The second shows the same steel after one hour's treatment at 900° C. The iron lines are still there, but a whole series of new lines has made its appearance. Clearly the heat treatment has caused the growth of crystals which were not present in the original material. The new lines are actually found to be due to the formation of two different carbides. The third photograph shows the steel after two heat treatments, one for one hour at 900° C. and the second for a few minutes at 1,200° C. The first heat treatment gives rise to the appearance of the carbides, but these are once more removed by the subsequent high temperature treatment. It is of interest that a treatment of this steel in the neighbourhood of 900° C. causes a serious depreciation of its magnetic properties, while after a steel has been spoiled by such a treatment it can be made to recover its magnetic quality by a subsequent heat treatment at 1,200° C. Needless to say, a chemical analysis of the steels would show no difference between them.

Another very important application of the X-ray method is in the study of the effects produced by " cold-working " metals. It is well known that processes such as rolling and drawing affect most materially the tensile and other properties of metals, and it is important that we should know as much as possible of what occurs during such processes. In a properly annealed metal specimen, the small crystals of which it is composed, are arranged entirely at random, some pointing in one direction, some in another, some in any given direction. As we " coldwork " the metal, X-rays show us that this random distribution is disturbed. As the process is continued the crystals begin to set themselves in a definite way. Thus, if we draw down an aluminium wire by passing it through a die we find that the crystals tend to set themselves so that one of the diagonals of the cube is parallel to the direction of rolling. Fig. 2 shows a typical picture of a cold-worked metal. Had the crystals been distributed entirely at random the pattern would have consisted of a series of uniform concentric circles surrounding the central spot where the un-diffracted beam has hit the photographic plate. The cold-work has resulted in intense spots appearing at definite points on these circles. From the position of these maxima of intensity it is a simple matter to work out the way in which the small crystals of the aggregate have set themselves.

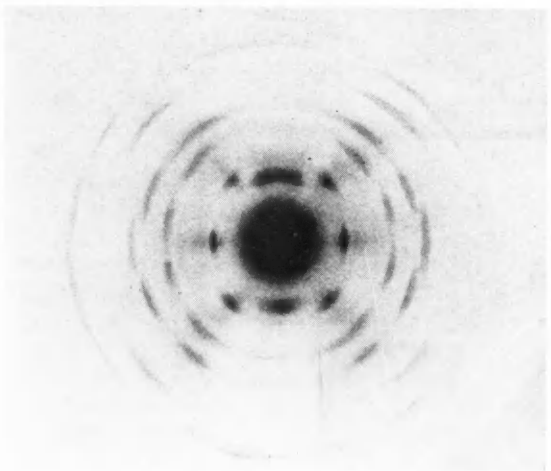


Fig. 2.
WHAT X-RAYS REVEAL.
The selective distribution of crystals is here illustrated in an example of cold-worked metal. It is also characteristic of many organic fibres.

Fig. 3.
MEASURING THE CRYSTALS.
As the crystal becomes very small the lines begin to lose their sharpness. From the amount of " broadening " the size of the crystals can be estimated.

This selective distribution is not confined to cold-worked metals. It is characteristic of many organic fibres such as cotton, wool and silk. X-ray patterns obtained from cellulose fibres have done much to extend our knowledge of the structure of cellulose. These patterns show us that, along the fibre axes, there are chains of glucose residues based on a structure of a ring of six atoms, five carbons and one oxygen, with additional oxygen atoms linking the rings together. The pattern repeats itself every two rings (every 10.3 ÅU.) and the unit usually consists of about one hundred of these rings. This distance of 10.3 ÅU. which marks the distance after which the pattern repeats along the axis of the fibre, is characteristic not only of cellulose but of many of its derivatives, such as nitro-cellulose and acetyl-cellulose. The change in the chemical nature affects only the way in which the chains are linked together and not the chains themselves. Mercerization processes also affect only the sideways relations of the chains.

There are other ways in which the X-ray patterns can be made to provide valuable information. In a crystal aggregate the crystals may have sizes varying from the visible to the ultra-microscopic, and it often happens that the properties of a substance depend on the size of the constituent crystals. When the

crystals become too small for microscopic measurement, it is possible by a study of the details of the X-ray pattern to obtain an estimate of their size. If the crystals are large enough the lines of the pattern are sharp and well defined. As the crystals become very small the lines begin to lose their sharpness until, when the amorphous condition is reached, the pattern disappears. From the amount of broadening the size of the crystals can be estimated. Fig. 3 shows a typical case of this broadening. The upper photograph is the pattern of metallic chromium, while the lower is that of an electrolytic deposit of chromium on copper. The extreme breadth of the line at the right-hand end shows that in this deposit the crystals are extremely minute. Crystal size has been shown to be of importance in connexion with many materials. Thus, for example, the spreading powers of certain paints increase as the grain size is reduced, while a small grain size increases the activity of certain catalytic agents. X-rays provide us with the only means of estimating crystal size when the crystals are extremely small.

There is still another cause which can give rise to a broadening of the lines in an X-ray pattern. If the crystals are under strain or otherwise imperfect then this will give rise to diffuseness of the pattern. This is most important in connexion with the study of metals, since it is very helpful to have some means of observing and measuring the amount of internal strain in a metal. Investigations have shown that such strain affects the electrical and magnetic properties.

These are a few of the main lines on which this method is being applied to industrial problems. Its possible field of application is almost unlimited, since it deals essentially with the structure of the solid and can be applied to the study of almost any solid. The information which it yields when taken in conjunction with that yielded by other standard methods of investigation must in the end lead us to a better understanding of the properties of our materials.

Research on Aircraft.

THE use of wind tunnels in research on aircraft was established in the early days of flying, and much of the information available to-day has been obtained by this means. The value of the tests naturally depends upon the extent to which the results obtained from small models can be applied to full-size machines. In the early stages it was found that results were not always confirmed in actual flight, but this difficulty has now been overcome by the construction of the compressed air tunnel at the National Physical Laboratory, Teddington. The apparatus consists of a wind tunnel enclosed in a steel shell, so that tests can be made in compressed air instead of in air at normal atmospheric pressure.

Recent research on the spinning of aeroplanes has been carried out by means of the tunnel and is described in the latest report of the Laboratory. At normal flying speeds it is a simple matter to maintain the path of a machine in a straight line, but at very low speeds this is usually difficult and the tendency in most aircraft is to fall into a spin. This is a motion in a tight spiral in which descent is rapid, and recovery to normal attitude can only be secured at the expense of considerable loss of height. Cases are not uncommon in which recovery from spin is dangerously slow, and it is imperative that research should be made into the conditions which lead to danger. Considerable progress has been made towards the solution of this problem by actually spinning aeroplanes fitted with recording instruments and by spinning small wooden models. The experiments have thrown important light on the way in which each part of the machine contributes to the air forces maintaining motion. In several conventional designs it has been found that under spinning conditions the fin and rudder become practically inoperative, or may even become reversed in their effects. As a result of the experiments, tests have been made to obviate the falling off in power.

A peculiar shielding effect of the tailplane on fin and rudder was found to be the prime cause of the trouble, a matter fairly easily remedied by raising the tailplane. One particularly vicious aeroplane has been cured of spinning troubles by this expedient, the raising of the tailplane having been coupled with a certain amount of deepening of the fuselage to add to the total fin area. The importance of the centrifugal forces arising from the rapid rotation is now recognized and theoretical study is proceeding parallel with the experimental investigation. The ultimate outcome of the research may well be the unspinnable aeroplane; but that will only be a possibility when the spin itself is thoroughly understood. One point which at all events is clear is that the distribution of the "masses" of an aeroplane must be related to its aerodynamic qualities before it can be said whether any given distribution is good or bad. For example, the placing of engines along the wings of a biplane may or may not lead to spinning trouble according to whether the upper wing is placed immediately above the lower wing or is set (or "staggered") in front of it.

The Canary Islands and Migrating Birds.

By David A. Bannerman.

British Museum (Natural History).

The Canary Islands are familiar ports of call to many travellers, but it is not generally known to what extent the islands are used as a halting place by migrating birds. An important addition to our knowledge of the Canarian migrants is discussed by the author, who has himself made a close study of the bird life in the islands.

ALMOST every year fresh records are being added to the already long list of migratory birds that regularly pass through the Canary Islands. The chance visitor to the islands will see little, if anything, of these birds, save perhaps to remark a few swallows which arrive in the latter part of April and are more or less plentiful until the end of June.

The great majority of the migrants, if they stop at all, remain for a very brief period in the islands, and many which pass by night must fail to sight the land altogether. The writer, who spent many months for eight consecutive years in the Canary Islands, studying the bird-life and making expeditions to all the islands on behalf of the British Museum, was greatly struck with the paucity of migrating birds which came under his direct notice despite a long list of published "records"; and in a report, which appeared over twenty years ago, wrote that it is to the tiny outlying islets of the eastern group that we must look for any fresh evidence about this always fascinating phenomena.

THE ROQUE DEL ESTE.

A view of the rugged island off the north coast of Lanzarote, Eastern Canaries, which was the scene of the discovery described by Mr. Bannerman. The photograph was taken by Mr. Cott.

The truth of that remark has now become apparent, for in a brief visit to what is but the fragment of a crater lip above the sea, a tragedy in the life of these birds of passage has been revealed. The Roque del Este—the scene of the disaster—is marked on the chart as a tiny speck off the north-east coast of Lanzarote, and is actually the first land which a bird would sight when making for the Canaries from Europe, that is to say, when on the autumn migration. The barren aspect of this inhospitable rock can best be gauged by reference to the photograph which is reproduced—not a tree, not a bush is in sight to break the monotonous aspect of El Roque; lumps of basalt, scoriae and ash, piled one upon another, are all that the eye rests upon. No dwelling of any description has been built on this inhospitable waste; even a goat would fail to survive on the island and no light-house flashes its beams to warn approaching ships. The island is given up to the crabs, one species of a lizard, one species of gecko, the sea birds, and to one resident species of land bird—the last the partial cause of the tragedy already alluded to.

Several naturalists have visited the Eastern Canaries from time to time, amongst them the present writer, who has spent several weeks under canvas on most of these outer islets, but, owing to the perpetual roughness of the seas, was unable even to attempt a landing on the Roque del Este. The islet remained a tantalizing sentinel viewed from my camp on Montaña Clara, and I had to be content with that. Now, last September its secrets have been revealed by a naturalist who succeeded in accomplishing what others have failed to do, and, setting out in a small open boat, was landed with great difficulty. Mr. H. B. Cott is already known to zoologists for his explorations on the Zambesi; the primary object of his expedition to the Canaries was to investigate the many varieties of lizards that have been described from that archipelago, where every island has its own peculiar race. The full account of his exploits in this field will be published shortly, but attention may here be

drawn to the fact that he is the first collector for many years to have landed upon another isolated rock—the Roque Salmore off the island of Hierro—and to procure the giant lizard, *Lacerta simonyi*, which is known to be confined to that rock.

But it is of what he found on the Roque del Este that this short article deals and therein lies a sequel to the journey of many unfortunate migratory birds. Having climbed to the summit of the island Mr. Cott was astonished to find the ledges and rocks strewn far and wide with the dead bodies of numerous small birds in all stages of preservation, but the majority little harmed, with all their limbs and feathers intact and the bodies fairly fresh. Some appeared to have been decapitated, while of others little remained but a bunch of mangled feathers and blood; forty of these bodies, in a good state of preservation, were picked up by Mr. Cott, carefully placed in spirit and eventually sent to the writer at the British Museum for identification. Here the possible source of their fate may be revealed, for every one of the bodies brought home by Mr. Cott could be identified with European breeding birds.

Obviously they were on their long journey to Africa to spend the winter, and had misfortune not overtaken them on this islet, would doubtless have gained the western shores of Africa, perhaps in the neighbourhood of the Rio de Oro. In addition to the crabs and sea birds which frequent the island, the East Rock is the breeding place of several pairs of Eleonore falcons, themselves summer visitors to the Canaries, and it is to these undoubted marauders that Mr. Cott would attribute the countless remains with which the rock was strewn. The bodies were well nourished and in many no feathers were out of place, but as Mr. Cott has explained, he was careful to collect only the undamaged specimens so that identification might be easy. How else could these wanderers have died, and how else account for the decapitated heads and loose wings which were in evidence on all sides?

The writer is still somewhat sceptical that Mr. Cott has solved the problem correctly in blaming the falcons, but in the absence of an alternative suggestion (the weather was calm and had remained so over the period that the migrants must have been passing the rock), we cannot but hold the falcons under grave suspicion, at any rate as regards the mutilated victims. The falcons' eyries were filled with young birds at the time and one family of youngsters now resides in Regent's Park in the Zoological Society's Gardens, into the cage of which the London sparrow may be warned against entering! It may be of interest to note that no less than twenty of the corpses collected were those of the common whitethroat, so familiar in our lanes and hedgerows in England, and a pleasant herald of Spring. Other species of which the remains came into my hands were all those of European birds, the majority of which occur in England in the summer, woodchat-shrikes, whinchats, redstarts, nightingales, pied flycatchers, aquatic-, melodius-, and grasshopper-warblers, and two Continental races of the chiffchaff amongst them.

The bodies of the dead birds were exhibited at the December meeting of the British Ornithologists Club, and an account given of how they were obtained. It was then generally agreed that although the falcons were doubtless responsible for the mangled remains, the majority of the birds must have perished from sheer exhaustion, or perhaps for want of water, the island being completely "dry." It is very rare, if not an unheard of fact, for a falcon to strike down a bird merely for the joy of killing, for once its own hunger

CHESTNUT WOODS ON GRAND CANARY.

The chestnut woods near Teror, Grand Canary, provide ideal conditions for the migrants and it is surprising that they remain for so short a time.

LOOKING TOWARDS SANTA BRIGIDA.

The Vega from Tafira, looking towards Santa Brigida and the Cumbres, Grand Canary. This and the previous photograph were taken by the author.

and the requirements of its young are satisfied, there is no further inducement to kill. Crabs, of course, are a severe menace to migrating birds coming within their reach, but I doubt if, in this instance, they can be held responsible. Major Flower, at one time Director of the Giza Zoological Gardens, once witnessed a quail, which had arrived exhausted on the shores of Egypt, seized by a crab and carried to the water's edge where the crab held it below the surface until drowned, preparatory to feeding upon it. There is in fact, nothing, as Major Flower states, that a voracious crab will *not* do !

The waste of bird life during the period of migration, particularly among small birds, is too appalling to contemplate. The instance just recorded is but one in a million, and the toll taken by the sea alone must be very great. Birds crossing the desert run an equally grave risk, as the dead corpses recently found strewn in the Lybian Desert bear witness. In contrast to the barren eastern islets, the five western islands are a paradise for migrating birds—and it is not to be wondered at that many Palaearctic species regularly visit the group on passage, while others come to spend either the winter or the summer in this favoured archipelago.

In scenes such as those depicted in the photographs taken by the writer in the Monte of Grand Canary, birds can find the ideal conditions for which they must surely aim. Here is water, cover in the form of woods and thickets, ideal nesting sites on every hand, abundant insect and plant life, added to which migrants find a climate more equable than that left behind in Europe or Africa. It is not surprising to find that these islands are the home of many insectivorous and grainivorous birds, closely related to our British species, which do not find it necessary to migrate at all. The marvel to my mind is that the passage migrants do not remain longer in the islands.

There is no space here to discuss the origin of the Canarian fauna—the subject has been dealt with by the writer in his book " The Canary Islands "—but it may be noted in passing that the Canaries can boast no less than forty-two endemic forms out of a resident population of sixty-one species. Although we have now a fair idea of the visitors which come to the Canaries during the spring and autumn migration, there are still a number of problems which remain unsolved. What happens to those birds which regularly pass *through* on their way south, and yet are not known to occur on the mainland of Africa anywhere south of the meridian on which the Canaries lie, nor yet are recorded from the Cape Verde Islands ? It may be postulated that these visitors from Europe may easily escape detection in such an immense territory as Africa, but we must bear in mind that there are a number of competent ornithologists on the West African coast-lands at the present day, and that we are peculiarly well situated at the British Museum for keeping in touch with all fresh ornithological discoveries on the West Coast. Collections are continually pouring in.

We know indeed that many of the species which swell the lists of Canarian migrants winter in our West African Colonies : Gambia, Sierra Leone, the Gold Coast and Nigeria ; every year we are learning more of the movements of birds up and down the coast.

Readers of *Discovery* who may chance to find themselves in the " Fortunate Islands " and who take more than a passing interest in ornithology, will find many engrossing problems which they may help to solve. Mr. Hugh Cott has set us an admirable example of what can be done in a very short visit.

Cultivating Animal Tissues.

By Cecil Gordon, M.Sc.

Department of Social Biology, London School of Economics.

The growing of animal tissue in the laboratory was attempted as long ago as 1902 but its practical possibilities, especially in the control of malignant diseases, are only now receiving full recognition. The author indicates how research may eventually lead to the artificial production of animals.

In his book *Daedalus*, Professor J. B. S. Haldane pointed out what reverberations might follow the production of living mammals outside the media in which development normally takes place. The same idea has since been made the basis of other speculations concerning the future of civilization, among them that put forward by Mr. Aldous Huxley in his latest book *Brave New World*. The production of a normal animal in the manner anticipated by Professor Haldane is not yet possible. The foundations of a method which may eventually enable us to produce an animal in an artificial medium are rapidly being laid.

The first step in the formation of an animal, after the sperm and the egg cell have united, is the splitting up of the fertilized egg cell. A mass of apparently similar cells is formed, and after this process has continued for some time parts of this mass appear to take on a definite form. The beginnings of organs can be recognized. From certain portions of the embryo, structures of a distinctive nature now begin to appear, but the process is essentially the same as when cell division first began and consists of the splitting up of cells into new cells which in their turn become the centres of a further differentiation. This takes place in certain media which differ from animal to animal, but the medium for any particular animal is normally constant. In the lower animals in the sea the medium in which development occurs is the water in which the parents themselves live.

Effect of Environment.

The effect of environment upon development in such forms is easy to study and has been studied rather extensively. In the higher animals the medium in which development takes place is more usually provided by the parent body. The method of study becomes increasingly difficult. For animals which develop in hard-shelled eggs—the oviparous forms—the adequate environment is provided by the egg. For those animals which produce their young alive—the viviparous forms—the adequate environment is provided by the mother. In either case it is necessary to prepare special media to induce the embryo to develop in the laboratory under conditions of direct observation—or as we more usually say, *in vitro*.

The term tissue culture is somewhat misleading. A tissue is a complex structure consisting partly of cells and partly of substances secreted by these cells or by other cells. When a tissue is placed in a medium capable of maintaining the division of its cells, the constituent cells separate themselves from one another and multiply without forming the auxiliary elements of which the original tissue was composed.

Early Studies.

The earliest attempts to grow animal tissue *in vitro* were made by Leo Loeb in 1902. Loeb did not use embryos. He studied the growth of pieces of living tissue from adult animals. The growth of new tissue even in adult animals is essentially the same process as the formation of tissue in our embryo. The cells divide, and new tissue is formed in exactly the same way. Loeb noticed that epithelial cells—cells forming those tissues which act as linings—would grow upon the clotted blood or lymph which exuded from the lips of an incision. He actually succeeded in growing epithelium on the surface of blood clot contained in a glass vessel, at the bottom of which had been found a fragment of tissue.

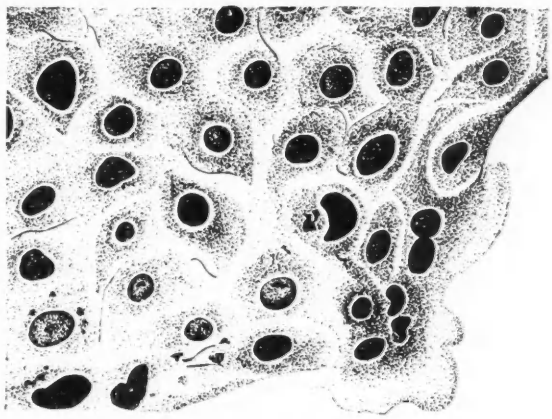
These experiments were the very first to be performed in the field of enquiry now known as tissue culture. The term cultures has been applied to the cells which have been grown in this manner. In 1906-1907 Harrison obtained a growth of tissue, that is, a division of cells, by placing a fragment of tissue in a drop of lymph upon a coverslip. The next notable advance was made by Burrows in 1910 and by Carrell in 1911. Those investigators used clotted blood plasma, and in addition devised a method which rendered the whole process aseptic and free from contamination. This was done by allowing the development to take place in a hanging drop of the medium placed under a cover glass, which was subsequently sealed over a cavity in a glass slide. By adding to the plasma an extract of embryonic tissue, the cells of the cultured tissue were caused to divide for an indefinite period. A further precaution of maintaining the whole process at the correct temperature is necessary.

The presence of coagulum in the blood plasma

used was found to be essential as cells only grow in media in which there is solid material to which they can attach themselves. Embryonic cells will continue to live in carefully prepared salt solutions of a certain concentration. But they will not divide, and tissue growths will not take place in these salt solutions unless something more is added. The substances which are found to be essential to tissue growth are most plentiful in extracts made from embryonic tissues. Tissue culture is essentially cannibalistic. The attempt to define what determines the survival of cells in artificial conditions has drawn attention to three groups of factors.

The first group of factors involves characteristics of the tissue cultured. Cultures from different types of cells differ from one another. The culture derived from an embryonic heart will be different from that derived from an embryonic thyroid, both cultures having taken place in identical media. Also the age of the tissue has been shown to be an important factor. A tissue from an old embryo will not produce a culture as readily as a tissue from a younger embryo. A second group of factors affecting tissue growth *in vitro* is the presence in the medium of substances which promote the division of the cells. Such substances are present in extracts from embryos, and they have been shown to decrease with the increasing age of the embryo used in making the extract. A third group of factors is the presence in the medium of substances inhibiting tissue growth.

FORMATION OF KIDNEY TUBULES.
Following the introduction in a tissue of a culture of connective tissues.



A PURE CULTURE OF KIDNEY TISSUE.
From "Essays in Popular Science" by Julian Huxley (Chatto & Windus).

Such substances have been shown to be present in blood serum, and are more plentiful in those samples of serum derived from older subjects.

The study of growth-promoting substances in culture media has yielded a suggestive fact concerning the nature of those which are derived from the white corpuscles of the blood. Extracts of the white blood corpuscles are found to contain growth-promoting substances. In the whole organism white blood corpuscles are attracted to any area where a disturbance has taken place, surround and remove any foreign materials which are present due to the disturbance. After all foreign bodies have been removed repair of the damaged tissues commences. The cells of the tissues there divide and form new tissues. This process of repair consists essentially of the growth of new tissues to replace those which had been removed, and as such is akin to all processes of growth. The growth-promoting substances of these white blood corpuscles have been found not to diminish with the age of the subject from which these were derived. In other words, the phenomena of inflammation and regeneration of damaged organs can be reproduced in isolated tissues.

The effect of temperature, of anaesthetics, and of other factors which might affect the growth of tissues *in vitro* have been extensively investigated. Perhaps the most arresting fact about tissue culture so far discovered is that of the appearance of the different types of cells, or cell differentiation as it is called. When cell division is first initiated, cells split up into those which are apparently the same as the parent cells. Yet when this process has gone on for some time it is quite apparent that there are different cells

in different regions of the same embryo. Once such cells have become differentiated and are then cultured *in vitro* further differentiation does not usually take place spontaneously. Such pure cultures have been built up and throw light on the successive events which give rise to various tissues, which are composed of several different types of cells. The interactions of the various types of cells have also been studied in this way.

If a piece of thyroid gland is cultured the cells change their form and fill the whole interior of the porous glandular tissue. If the glandular elements alone are placed in the culture medium these gradually die out, but if a culture of those cells which give rise to connective tissue is added, regeneration of the whole gland occurs, and a culture similar to that obtained from the complete thyroid is obtained. Similar work has been done with pure cultures from rat carcinoma—malignant growth popularly included under the term cancer. Erdmann implanted a pure culture of carcinomatous tissue into a rat, and did not give rise to a tumour. When a culture of cells of connective tissue was added to this implantation of carcinoma cells, a tumour was produced. Here again the differentiation of a tissue is seen to depend on substances present in an adjacent tissue. A further example of this dependence is provided by experts on the embryonic heart. When the portion of a frog's embryo which normally gives rise to the heart was cultured *in vitro*, it becomes a rounded, closed, palpitating mass entirely different from the embryonic. When transplanted to its original medium within the embryo, it once again assumed its normal form.

Origin of Blood Corpuscles.

When certain embryonic tissues are cultured, isolated groups of cells detach themselves from the main mass. If these isolated groups are removed and cultured independently they are found to be entirely different from the main mass of cells in the original culture. In some cases these isolated cells are identical with blood corpuscles. By culturing tissue from different regions of young chick embryos it has been found that blood corpuscles are only formed in this way from tissues taken from particular parts of the body. Hence it is possible to determine the seat of origin of the blood corpuscles in the normal course of development.

There are certain regions of the embryo which cannot be cultured in artificial media. That is to say, their constituent cells do not grow and multiply. The regions which have this property are peculiar in another way which is of the greatest significance for the study of how the embryo develops. When tissues from such regions are grafted into other situations, the tissues there develop the characteristics of the tissues of the region from which the graft was taken. They thus control the development of differentiation of adjacent regions and are spoken of as organization centres.

Tissue Grafting.

In this way areas have become the seat of structures which normally would not have been there. The hind portion of a chick embryo can be developed alongside the front portion by the transfer of the organization centre. By transplanting the organization centre for head growths to another embryo a double-headed embryo can be produced. This can also be done in a duck embryo by the graft from a chick embryo. There are limits to the age of an embryo from which an effective organization centre may be taken, as well as to the age of an embryo which may be affected by an organization centre.

Apart from the more remote applications of tissue culture which might affect the whole structure of society, there is an application which may become of social significance rather sooner. All tumours whether malignant or benign are purely and simply abnormal growths of tissue. Hitherto attempts to control these growths have been either failures or only partially successful. The mortality from malignant growths or cancer is at present enormous, and this in spite of the fact that no efforts to counteract this terrific scourge have been spurned. Of all the time and energy devoted to the study of cancer, comparatively little has been in the direction of the elucidation of the true nature of these growths.

A better understanding of the way in which these growths arise, the conditions conducive to their growth, and a knowledge of what might arrest them *in vitro* could quite conceivably have enormous clinical application. There is at present a considerable amount of work being performed in the study of these malignant growths, utilizing the technique developed in the study of tissue culture. Many competent authorities are already of the opinion that the best results in this field will appear from the work of those people who have approached the subject from this aspect. Tissue culture will then rank with electro-magnetism, X-rays, radio-activity, radio-telephony, genetics and other branches of science too numerous to mention, whose initial study was regarded by the layman as a sheer waste of time and energy; and whose subsequent applications have wrought such enormous changes in every-day life.

New Research in Water Distilling.

By Bruce Bryan.

Water distilling plants have, of course, been carried for many years by ocean liners, but expense has prohibited their general use. To combat the decreasing water supply in California an American engineer has perfected a still which is claimed to be capable of producing economically 42,000 gallons of pure water a day.

In California the natural water supply has for some years been decreasing to an alarming extent. This is due to the increasing population of the state, the demands of modern industry with its water-cooled machinery, and to the growing needs of irrigation. Rainfall has dropped far below normal during the last decade, and has never been abundant in the desert regions of California. The water supply of Los Angeles, a city of nearly two million inhabitants, comes from the distant Owens Lake, and is dependent on the efficiency of the aqueduct through which it passes. These problems have led a Californian engineer to invent a distilling apparatus which converts salt water into clear drinking water on an economical basis. The apparatus readily converts even sewage into distilled water at the rate of 1,000 barrels per day. Mr. Henry Lea perfected the invention only a few months ago.

The new still is unique but simple in operation. Distillation comprises the vaporizing of a liquid and the condensing of the vapour. The rate of vaporization increases with temperature and decreases with pressure, and the released vapour becomes pure distilled water on condensing. Thus salt water and heat are all that is required in the process. While the cost of pumping the water is almost uniform, there are various means of lowering the cost of heating, primarily by reducing the ratio of salt water to the distillate. Tests suggest that whereas the present practice of distillation requires from 15 to 30 pounds of water per pound of distillate produced, actually only seven pounds need be used.

Saving the Heat.

Realizing that in proportion to the heat conserved within the still correspondingly less fuel is needed to maintain the temperature, the inventor has effected a saving by the construction of a machine which "re-cycles" part of the heat. Tests have also demonstrated the fact that distillation can be maintained and the thermal losses incidental to operation fully covered by a gross heat input of 600 B.Th.U. per pound of distillate, provided the proper operating cycle is established. Making no provision for losses, theoretically the minimum heat requirement for the simple evaporation of water from 62° F. is 1,116 B.Th.U. But the losses incurred in present practice frequently bring the total heat consumption up to 2,200 B.Th.U. per pound of water distilled.

Vaporization is confined to the portion of the liquid which, on being condensed and cooled, will yield the greatest quantity of heat capable of being transferred to the "raw feed," that is, the sea water to be distilled. Four distinct flows of heat are constantly re-cycled through an arrangement of "steps." Distillation is entirely carried out by the heat so trapped and re-cycled, the only additional heat required being that needed to offset loss in operation. Both evaporation and condensation are combined as a single operation.

Simple Principles.

The working of the apparatus is based on simple principles. Except for the addition of a pump for the supply of salt water, the still is complete in itself. Within the single machine sea water is heated and vaporized; the residue is cooled and discharged at any predetermined degree of salinity up to saturation; the vapour liberated is immediately condensed, cooled and discharged as pure distilled water; gases released on boiling are cooled and separately discharged; the air required for combustion is pre-heated, and the products of combustion are effectively cooled. The apparatus is capable of handling 7,000 barrels of salt water per day and distilling 1,000 barrels. It stands 30 feet high, with the addition of a six-foot stack, giving a total height of 36 feet. The still contains twelve evaporating chambers, where an arrangement of steel sheets separated by cast-iron bars makes up a series of "trays."

The fire-box, five feet in height, is liberally insulated and has sufficient area to insure complete combustion before the gases reach the heating tubes. The stack at the top is fitted with an adjustable damper, permitting accurate control of the draft which passes through the still. A large self-sealing door on the fire-box provides for the insertion of gas burners and for the replacement of fire-brick, while the door itself is fitted with a Pyrex glass window for inspection of the flame. Two sea water outlets, two vents for entrained gases, and one outlet for residue are provided. If absolutely pure distillate is desired, the parts in

contact with the distillate may be tinned or enamelled. The entire structure is self-supporting and rigid, and is carried on heavy cast-iron members bolted to the shell of the unit and to the concrete foundation.

The operation of the still is simple and only requires a periodical inspection of the flame in the fire-box. The sea water enters an inlet at the front of the still and passes into the condenser tubes under pump pressure. It then travels through a series of tubes until it reaches the top tray. The water returns through the trays to an outlet at the rear of the still. In the stack above the fire-box a draft draws a current of air through the still which travels upwards through the tubes to the fire-box, where the gas is ignited and combustion takes place. The products of the combustion pass upwards through the tubes, yielding 85 per cent of their heat to the downcoming water. They are then discharged through the stack. Vapour is produced as the water in the tray absorbs heat. The vapour eventually finds its way to the condensing zone where it loses its latent heat and becomes distilled water. The latent heat is transferred through condenser tubes to the sea water in the still. Thus the heat is trapped within the still, and with the exception of possible heat leakage, must continue to travel indefinitely within the cycle in which it has started.

The condensed vapour next falls from one nest of tubes to a colder nest immediately below. This process gradually robs it of heat, until after having reached the lowest and coldest nest it is discharged from the still at a temperature only fifteen degrees above that of the sea water entering the unit. In addition, the heat of the condensate is also trapped and proceeds to re-cycle. Naturally the sea water remaining in the trays increases slightly in salinity as it travels down, and it has been relieved of nearly the desired amount of vapour as it leaves the tray just above the fire-box. Its temperature, however, is still 212° F., and its immediate discharge would be an unnecessary waste of good heat. It is therefore dropped to the tray immediately below where its heat is drawn upon for the continuance of evaporation; the vapour so produced is condensed and cooled in the same way as the vapour from above.

Many Uses.

There are, of course, immediate markets for pure distilled water. In industry it is used in steam boilers of all kinds, doing away with the losses and dangers attendant on corrosion which results from the use of plain water. The use of distilled water in such cases reduces labour and saves considerable sums in boiler fuel. It also goes into the making of beverages, dyes, extracts, bleaches, paper, ice, photographs, soap, sugar, textiles, and many chemical products. Among the largest users are breweries, distilleries, laundries, tanneries, and storage battery stations, and it is extensively used in medicine. It has a wide application in the petroleum industry, which despite motion pictures is still the largest industry in California.

In the Oilfields.

Mixed with rotary mud in the drilling of an oil well, unless there were a high mineral content in the mud itself, distilled water should insure better service and longer life in drilling apparatus. The salt water frequently encountered in boring an oil well could readily be distilled into pure water, and if necessary could be put to good advantage for drinking purposes. In water wells, where occasional oil is brought up with the water, such a unit could distil a purer water product than if the water had come up free from oil in the first instance. Some of the water wells recently drilled in southern California have revealed various degrees of salinity owing to their proximity to the sea and its unavoidable encroachment. Here again a distillation unit could play an invaluable part. Oil-prospecting parties and scientific expeditions in isolated districts might use a smaller adaptation of the still provided a source of raw fluid were available.

In connexion with Mr. Lea's invention California's dwindling water supply is, of course, the primary consideration. The watersheds of the state have yearly been depleted through forest fires and the felling of timber. Where formerly the ranch owner could pump water from a depth of perhaps 17 to 20 feet, he may now find it necessary to reach a depth of 70 feet or more. His equipment is not sufficient to serve him in such a case, and usually he is unable to afford more elaborate pumping apparatus. At the rate at which a modern city consumes water, variously estimated at from 75 to 150 gallons a day per capita, it is easy to see the enormous volume required for every-day use, not only for drinking purposes but also in industry. Should the aqueduct which conveys the water to Los Angeles cease to be efficient, a problem of the first importance would arise. In Los Angeles, with the limitless resources of the Pacific at its disposal, the new system of distillation should offer a solution to the problem. The new still operates at the rate of 42,000 gallons of pure water a day. To supply a city with 2,000,000 gallons of water each day would require the operation of approximately 48 stills. Apart from the cost of manufacture, and the slight expense of pumping in the sea water, there remains only the cost of heating, which is slight.

Book Reviews.

At Home with the Savage. By J. H. DRIBERG. (Routledge. 7*s*. 6*d*.).

Books on etiquette have unfortunately gone out of fashion in company with good manners. But if "deportment" has been dispensed with by advanced society, it is certainly of the first importance among primitive peoples. The African native has been disciplined since childhood in every form of polite intercourse, according to his own odd standards: when spitting is a recognized form of greeting, a refusal to spit is clearly an unfriendly act, and is naturally resented. When Mr. Driberg first went to Africa he had never heard of the word anthropology. Among district commissioners he was unfortunately not unique in this respect. It says a great deal for the change which has taken place in the attitude of native administration generally that the author is now a lecturer in ethnology at Cambridge. His work in the Uganda Civil Service brought him into the closest touch with primitive peoples, and his book should be prescribed as a handbook for all who contemplate a similar career.

It is clearly impossible to give a general account of what constitutes good manners in native societies. As no standard is, of course, applicable to all, neighbouring tribes may have entirely different codes. As the author points out, in a tribe like the Baganda, ruled by a powerful monarch, subservience is reflected to a marked degree in speech and manner: a visitor of high rank is met by complete prostration on the road. Among the Lango, however, rank counts for little. Native etiquette, like our own, is often founded on superstition. It is the height of bad form to walk on the native's shadow, because one may be intending a mischief to one of his souls (which inhabit the shadow). On the other hand, sound sense underlies many social obligations. A woman precedes her husband because the women are notoriously free in their love and the husband very sensibly prefers to keep his wife in view. Mr. Driberg has much that is useful to say about such all-important aspects of native life as the significance of the clan, the tribe and tribal government. Religion and magic are naturally dealt with at some length, and there is an interesting chapter on native law. The book contains little new information for the specialist, but it is a most valuable introduction to the more exhaustive and specialized works set out in the bibliography. To the "popular" reader and the student of Africa it should make a wide appeal. The index to tribes is an asset.

Digressions of a Man of Science. By SIR DANIEL HALL. (Hopkinson. 7*s*. 6*d*.).

This volume of essays was written, Sir Daniel Hall explains, because the business of the world is carried on by words, and it is up to the man of science to show that he can shuffle the counters about with the best. Although the author is chiefly known as a specialist in agricultural science (or as he modestly says, "a bottle-washer attendant on the farmer"), this account of his digressions reflects his many interests—as a traveller, as a bargain hunter in the auction room, as a tulip fancier, as an authority on architecture, as a believer in "those great achievements wine and art."

In a chapter entitled "What Has Science done for Farming?" Sir Daniel shows that the human element in agriculture presents far greater difficulties than the laboratory problems. Between the incubation of scientific research in the laboratory and its emergence as a commercial process for the use of the community there may be a long and tiresome period of working out. How are the intermediary stages of development to be obtained in agriculture? The investigator may have the inspiration and obtain results in the laboratory, but there is no capitalist organization on a large scale to make it worth while to embark on the working out of a commercial process. Some of the improvements effected by science can easily be disseminated among farmers. For example, a new fertilizer is quickly taken up; farmers are easily brought to see its value, although as the manufacturers of the synthetic nitrogen fertilizers have learned to their cost, it is quite another matter to induce the rank and file of the agricultural community to alter their methods so as to utilize fully the new resources at their disposal. "The contrast between the modern development of industry and farming is extreme. Walk through a sugar-beet factory or even a milk condensing factory; examine the mechanism, the technical elaboration of the methods and the accuracy of the controls; and then go outside among the little farms that supply the raw material to the factory—the beet or the milk! It is essentially a comparison of the world with science and the world before science. Nothing could be more impressive than a visit to the great Billingham factory making the synthetic nitrogen fertilizers. . . . Then go to one of the nearby farms which have to use the products of Billingham. Instead of the twentieth century in full tide, you are back close to the eighteenth century, not very remote, indeed, from Roman farming."

Even though science has brought disaster on many a kindly industry, Sir Daniel Hall stresses the fact that the only cure for the destruction wrought by science is more science: we must either join the broad stream of human progress wherever it leads or enter one of those backwaters in which we see other dead civilizations stagnating.

There is a chapter entitled "Speech Day" which opens in a delightfully breezy way. It is an address to the boys of Manchester Grammar School. Sir Daniel regrets that he cannot open with the usual gambit—popular as it may be. "I cannot say that I never won a prize and was always near the bottom of the form. But then I am neither a politician nor a general."

The Natural History of Wicken Fen. VI Parts. Edited by J. STANLEY GARDINER, F.R.S. (Bowes & Bowes. 25*s*.).

With the publication of the sixth part, Professor Gardiner's fascinating work on the natural history of Wicken Fen is completed. The earlier parts have been issued at intervals since 1923 and each is obtainable separately. Among other articles in the volume under review, Mr. L. E. S. Eastham contributes an interesting account of the fauna. Wicken Fen is unique among the properties held by the National Trust. It is a relic, but unlike most lands held by the Trust it undergoes constant change, a change which is to a large extent beyond human control. Wicken represents a small piece of the ancient fenland which existed over a large part of East Anglia before the drainage of the Great Level was undertaken in the seventeenth century. As such its fauna has a peculiar interest for biologists, since it might be expected that it would differ markedly from that of the surrounding cultivated lands and contain elements reminiscent of the more extensive fen areas of former days. Its preservation has for this reason been secured for all time. But although it represents a piece of original fen the task of preserving it in this state does not consist in allowing it to go wild as an untrodden sanctuary. Paradoxical as it may appear, a simple type of cultivation is necessary in

order to preserve to the Fen the features which characterized the whole of the East Anglian fens before the seventeenth century drainage schemes. One of the greatest difficulties with which the zoologist is confronted is the discrimination between fen and non-fen species. Attempts have been made to classify the beetles caught into true fen species, non-fen species which have wandered in from without, forms normally found in the Fen but which are known to belong to other than fen habitats, and lastly forms with a wide distribution but which can live on the Fen.

The Fen is a watery place and it is strange for the visitor to be told that the aquatic fauna is not peculiar to a fen environment. The lodes, drains and water holes seem to constitute its main physical characteristics, and the naturalist is tempted to jump to the conclusion that in these waters would be found animals belonging to the Fen only. Such is not the case. For instance, Professor Balfour-Browne tells us that the drains and lodes contain no species of water beetle not found in the waters of surrounding areas where cultivation has changed conditions. The waters present no physical or chemical features distinguishing them from other neighbouring waters and the beetles found in them are there because of climatic conditions rather than conditions specially pertaining to the Fen. In spite of this there is room for much investigation. There is evidence of a change of fauna in the water beetles, some decreasing and others increasing in number even during a short period of four or five years. Further, certain species reported in 1855, 1843, and 1829 are no longer found there. We know nothing of the reasons for these pronounced changes nor do we know anything of the possible relationship existing between aquatic animal life and the nature of the bottom or of the plant life in the water.

Mr. Eastham urges the importance of team work in ecological research at the Fen. He suggests that a tradition of continuous work by zoologists should be established, irrespective of changing personnel. The excellent census already obtained forms a solid foundation for further research.

Digging up Biblical History. II Vols. By J. Garrow Duncan. (S.P.C.K. 12*s.* 6*d.*).

In these two volumes, an expansion of the Croall Lectures for 1928-9, the author surveys recent advances in our knowledge of the archaeology of Palestine with special reference to their bearing on Biblical narrative. In the first volume he deals with the evidence, period by period, yielded by the various sites of excavation throughout the country which furnishes a more or less continuous story from neolithic times, through bronze and iron ages, down to the Roman occupation. In the second volume he utilizes the material discovered to build up a picture of the culture—dwellings, the arts, technology and religious beliefs—of the early inhabitants of Palestine.

The archaeologist in Palestine is both fortunate and the reverse. The extensive use of the numerous caves of the country throughout its history has brought about the preservation of much that otherwise would have perished, as was shown by the epoch-making discoveries of Professor Macalister at Geyer. On the other hand, their continued use and the occupation of the ground above them has often confused the evidence, rendering interpretation a matter of difficulty, except where the explorer finds such distinctive data as, for example, neolithic pottery. Again, there are gaps in the evidence which it has not been found possible to fill as at Jericho where Professor Garstang is now at work. This may at times be due, as is here suggested, to the character of the Hebrew occupation in its initial stages. It is surprising that the author has passed so lightly over Miss Garrod's important cave excavations. The reference to Professor Sir Flinders Petrie's palaeolithic finds at Bethpelet is admittedly a later insertion in the text. Except in these matters, Mr. Duncan's book is an exceedingly useful account of what we now know of the prehistory of the country. On larger issues and racial problems, as a brief foreword indicates, it illustrates the danger of premature generalization.

A Naturalist in the Guiana Forest. By Major R. W. G. Hingston. (Arnold. 18*s.*).

Major Hingston, leader of the Oxford University Expedition to British Guiana, has really given us two books in one. The first is an account of life and work in the rain forest, and the second a detailed description of a long series of interesting and important observations on spiders and insects, illustrated by a large number of drawings. While the second part will appeal rather to the specialist, who find there an abundant and important contribution to the raw material of philosophic entomology, the first part is of great interest to the general reader. Readers of *Discovery* will remember the author's articles on both of these subjects soon after the expedition returned.

Those who have never seen the equatorial belt of rain forest can have little idea of what it is like, and one of the most impressive features of this book is the description of contrast between the floor and the teeming surface of the canopy. "There are no herbaceous plants, nowhere a bright flower; here and there it supported clusters of fungi, and the twigs and stems were decorated with lichen and moss, vegetable refuse over this debris of centuries. . . . Everything was either fully decayed or fast becoming soft and powdery, the carpet underfoot was all crumble and rot." And the top? They chose a baromalli tree that rose like a smooth pillar and reached a height of 120 feet. They made a station at 120 feet and looked out upon the surface of this ocean of green. This is what they saw: "We had a clear outlook over six or eight square miles of roof, over a green plain . . . plenty of variety . . . it was a brilliant, multi-coloured, carpet-like expanse, glowing and sparkling in the full sunlight and vividly impressive through its tremendous contrast with the gloomy flowerless world underneath: it harboured a quantity of animal life. Vultures and swifts floated over it; humming-birds, parrots, toucans, macaws lived perpetually in its topmost branches, dragonflies swarmed around its summits and huge morpho butterflies floated over it. Flies worried the observer, grasshoppers and crickets hopped among the branches, ants ran over the stems and foliage, huge mygales and foul millipedes moved over the bark and spiders made their snares. The canopy abounded in life. We could observe the tiniest fragment of it."

As the author points out, this forest must be of much greater age than our temperate forest belts, to have given time for the highly specialized forms of life to develop, such as the monkeys with prehensile tails and the sloths among the mammals. Apart from the work of Allee on Barro Colorado and of Beebe in British Guiana, there has been little attempt to tackle the exploration of this wonderful world. The members of the Oxford Expedition were pioneers and their description of the technical and physical difficulties to overcome is not the least interesting part of the book. But when we think of the vastness of that world, of the incredible exuberance of life, both animal and vegetable,

and of its extreme inaccessibility, it leaves the impression of hopelessness; how shall we ever cope with it or learn to know and describe one small fraction of the countless multitudes of species remaining to be discovered in the canopy of the Neotropical Region?

Ornithologist's Field Note Book. By RONALD M. GARNETT. (Rounce & Wortley, Holt, Norfolk. 6*s.* 6*d.*).

To compile an adequate field note book is difficult. Of hand-books there are plenty, but they are often too heavy and cumbrous an addition for the watcher already over-burdened with field-glasses, telescope and perhaps a camera. Mr. Garnett's little volume overcomes this objection; it weighs only about six ounces, and slips easily into the pocket. It includes blank pages for further notes, which can be either interleaved or inserted at the end, according to taste, as the book is of the "ring-leaf" type. Short descriptions are given of all the birds on the British list. Some field note books irritatingly omit the rarer species, which are just those as to which an observer requires guidance. We have tested the particulars, and find Mr. Garnett's notes accurate and helpful. One good point is that he tells you when the identification marks of some sub-species are so slight as to be indistinguishable in the field; such hints save much waste of time. We found the notes on the waders especially useful; we understand that Mr. Garnett lives in Norfolk, a county much haunted by this very puzzling species, and he seems to have made good use of his opportunities. The essential distinctions between the pipits, the various warblers, ducks, grebes and divers are also very clearly stated.

We do not expect to discover in a book of this kind, where brevity is a *sine qua non*, any imaginative touches, but Mr. Garnett finds space to remark that the magpie's flight "suggests a series of efforts to prevent itself falling," and that the long-tailed tit on the wing "looks like a cork with a feather stuck into it" both are happy phrases. There is a frontispiece by Mr. Roland Green, and an adequate index. We feel sure that every bird-lover will soon find Mr. Garnett's guide essential for field work.

Lightning. Lightning Stroke and its Treatment. By H. A SPENCER. (Balliere, Tindall and Cox. 5*s.*).

As Government medical officer in a large rural district of that "home of the thunderstorm," Eastern Transvaal, the author had wide experience of the catastrophes caused by lightning, and made a special study of the subject from a scientific as well as a medical aspect. Mr. Spencer's book consists of notes of many of the most interesting cases of casualty caused by lightning that came within his twenty-five years' experience, and explanatory observations of the causes and courses of lightning. While England rarely, if ever, experiences thunder-storms of African severity, there is much in Mr. Spencer's book that may be read with interest and profit in this country. Members of the medical profession may gain instruction from every chapter, especially from those in which the author explains how people apparently killed by lightning stroke have been revived by artificial respiration. The layman's interest, on the other hand, will be centred on those sections that explain how to avoid the consequences of lightning.

It is well known, of course, that lightning will often avoid an obvious conductor and strike what seems an unlikely objective. One of the reasons is that a stream of warm air offers more ready conduction than the cooler and more condensed air about it. This explains why lightning will often strike down a chimney when a fire is burning in the grate, and why it will enter open doors and windows—even though its course is thereby violently deflected—in order to travel along the current of warm air emerging from houses. Mr. Spencer records several instances of lightning travelling parallel with the ground along the warm track of air left behind a team of oxen drawing a wagon. Bell tents, too, are frequently struck because of the stream of warm air that emerges through the ventilators at the top.

The Call of the North. By H. H. HOUBEN. (Elkin Mathews. 15*s.*).

Thirty Years in the Golden North. By JAN WELZL. (Allen & Unwin. 10*s.* 6*d.*).

This year has seen several notable additions to the literature of Polar exploration. As a brief history of Arctic voyages large and small from Pytheus of Marsiliae in the fourth century B.C. to the Graf Zeppelin last year, Professor Houben's book is to be welcomed. If it contains little new information, it is a painstaking and useful summary and the author possesses descriptive powers for which his subject gives him ample scope. Mr. Welzl's book is of a very different kind. Born in 1870 the son of a Moravian shop-keeper, the author was an unskilled labourer and worked his way to the Arctic in a spirit of adventure rather than from scientific motives. The book is none the less of much scientific interest, for this observant traveller has much to say about the life and customs of the Esquimaux whom he met on unusually intimate terms. Mr. Welzl spent thirty years of his life in the Arctic and has returned there to end his days. His reminiscences were dictated to two journalists who have had the good judgment to preserve the simple charm of the narrative without journalistic embellishment. The author's haphazard wanderings were largely among the group of islands known as New Siberia. The book describes his impressions on his long and leisurely trek through Siberia to the Arctic Ocean, along the Yukon from source to mouth and in many desolate regions. An instructive if depressing chapter is entitled "The Horrors of Polar Justice." The book is a remarkable record of personal adventure, for the most part solitary, and often under conditions of extreme hardship.

The Sexual Life of Savages. By BRONISLAW MALINOWSKI. (Kegan Paul. 15*s.*).

It would be unnecessary to do more than call attention to the third edition of a book of which the main body of the text remains unaltered, if it were not for the fact that Professor Malinowski has added a lengthy preface in which he restates his aims and methods in the study of primitive peoples, and more particularly when observing in the field. On several occasions he has dissociated himself from what he has termed an "antiquarian" study of anthropology which is concerned with origins in custom and the evolution of social institutions and religious belief. He here explains why he adopts this standpoint and why, in his opinion, the "functional" study of institutions, which he has elaborated as a result of his experience in the field, should now take the place of the traditional method. Professor Malinowski has defined "functional anthropology" as "aiming at the understanding of the nature of culture rather than at conjectural reconstructions of its evolution or of past historical events." Yet it turns out that the author is by no means averse from antiquarians—in fact, he owns himself an

antiquarian in most positive terms—but it is an antiquarianism with a very different orientation from that of the seeker of origins through the collection of isolated facts which are no more than formally related.

Professor Malinowski's statement must be studied as a whole. It is of extreme importance both for the scientific worker and for those interested in the practical application of the results of anthropological studies to the administration of dependent races. The reader here has the additional advantage that in this book he has under his hand an example of the application of the method to one of the most significant sides of life among a primitive people.

A word of thanks is due to the publishers for their enterprise in reissuing this valuable work, with its numerous and excellent illustrations, at a reduced price.

The Meaning and Philosophy of Numbers. By LEONARD BOSMAN. (Rider. 5*s*.).

Why is the number seven popularly supposed to be lucky? There is, according to those who study the science of numbers, something more than superstition behind that belief. It is not only the number seven that possesses a peculiar significance for numerologists; they hold that all numbers have an "inner meaning" and in the practice of their theories have revealed interpretations of certain books of the Bible, notably *Revelation*, that have a claim to be considered seriously. This is not a textbook of any particular system of numerology; it surveys the whole field and explains the various methods of divination by numbers. It is not a book for a casual hour. Although its purpose is principally explanatory, it is erudite and sometimes abstruse. The author assumes the teaching of Pythagoras to be correct, and examines differing theories, not always sympathetically.

The essence of numerology is that numbers have, or originally had, a meaning, just as letters and combinations of letters to form words convey ideas. Thus numbers assume an entirely different significance when applied to the Book of *Revelation* than when they were simply taken to indicate periods of time. The student and practitioner of numerology will find this book most interesting and helpful.

Chemistry, Life and Civilization. By HUBERT T. S. BRITTON. (Chapman & Hall. 10*s*. 6*d*.).

Dr. Britton's "popular account of modern advances in chemistry" is well planned and shows wide knowledge both of his science and of its practical applications. But he overrates the capacity of "the reader who has acquired no previous knowledge of chemistry," and he has made the book difficult reading by trying to include too many interesting and important subjects. Teachers will find it extremely suggestive, and advanced students will be encouraged by discovering the significance of reactions that may seem to have only a theoretical value. Dr. Britton begins with elementary combinations and compounds, passes on to "the riddle of the universe" and the possible means by which life emerged on this planet, discusses at some length the chemistry of the body, digestion, vitamins, and so forth, and then considers chemical industry in its many aspects with a final chapter on power. The exposition is highly compressed but it is sound and instructive and makes one realize afresh the tremendous part that chemistry plays in our modern civilization. The book is well illustrated with diagrams and photographs. If it could be expanded and simplified, it would appeal to a wider circle of readers.

An Account of Tibet. The Travels of Ippolito Desideri. Edited by FILIPPO DE FILIPPI. (Kegan Paul. 25*s*.).

Few of the works issued in "The Broadway Travellers" series surpass in intrinsic interest Desideri's "Account of Tibet." Not only is it the earliest description by a European of the country and its peoples, but its value for the study of Tibetan religion—even though Buddha is not even mentioned—and Tibetan social organization two hundred years ago is unique. Desideri reached Lhasa in 1716. He was received cordially by the ruler of the country who afforded him the fullest facilities for the study of the Sacred Books, a task upon which he entered with enthusiasm, but in no unsympathetic spirit, in order to prepare himself to argue the case of Christianity against transmigration with the native priests. Unfortunately, the Tatar invasion of 1717 prevented what would undoubtedly have been a most interesting and instructive debate. His devotion to Tibetan studies, including the language, throughout his story gives his record exceptional value.

Desideri's "Account" is divided into four books, of which the first and last deal with the journey to and from Lhasa through India. The second and third are concerned with the manners and customs of the people as well as their religious ritual and dogma. Although the author never abandons his outlook as a Christian missionary, as shown, for example, in his animadversions on Tibetan marriage customs, or his belief in the agency of the devil in securing the succession of Grand Lamas, yet in his record of facts he exhibits a detachment unusual even in more modern times. Taken purely as a travel book, it affords a lively and entertaining narrative.

The editor has supplemented the text with valuable notes and references to authorities which will supplement or correct Desideri and there is an excellent historical introduction.

How Things Behave. An Introduction to Physics. By J. W. N. SULLIVAN. (Black. 2*s*. 6*d*.).

This is an excellent addition to a useful and attractive series. There is a growing demand for reliable "popular" scientific books at a moderate price, and the "How-and-Why" books, each written by an acknowledged authority, should find a warm welcome. This book is in the form of a series of conversations which explain to the layman the principles of heat, light, sound, electricity, the atom, the action of the sun and moon. The book is primarily intended for younger readers, and can be recommended as a useful and engaging addition to school textbooks. It is illustrated by Mr. T. L. Poulton, and the series is edited by Mr. Gerald Bullett.

Monsters of Primeval Days. With Notes by W. E. SWINTON. (Figurehead. 2*s*.).

Twenty-four photographs of the models of prehistoric monsters recently constructed under the direction of British Museum experts are reproduced in this book. Some of the photographs were published in *Discovery* last year. Accumulated evidence has enabled the modellers to reconstruct such animals as brontosaurus, diplodocus and uintatherium, together with the surroundings which they frequented. The results are most realistic and the photographs are excellent. A cheaper edition is available for use in schools at one shilling.

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